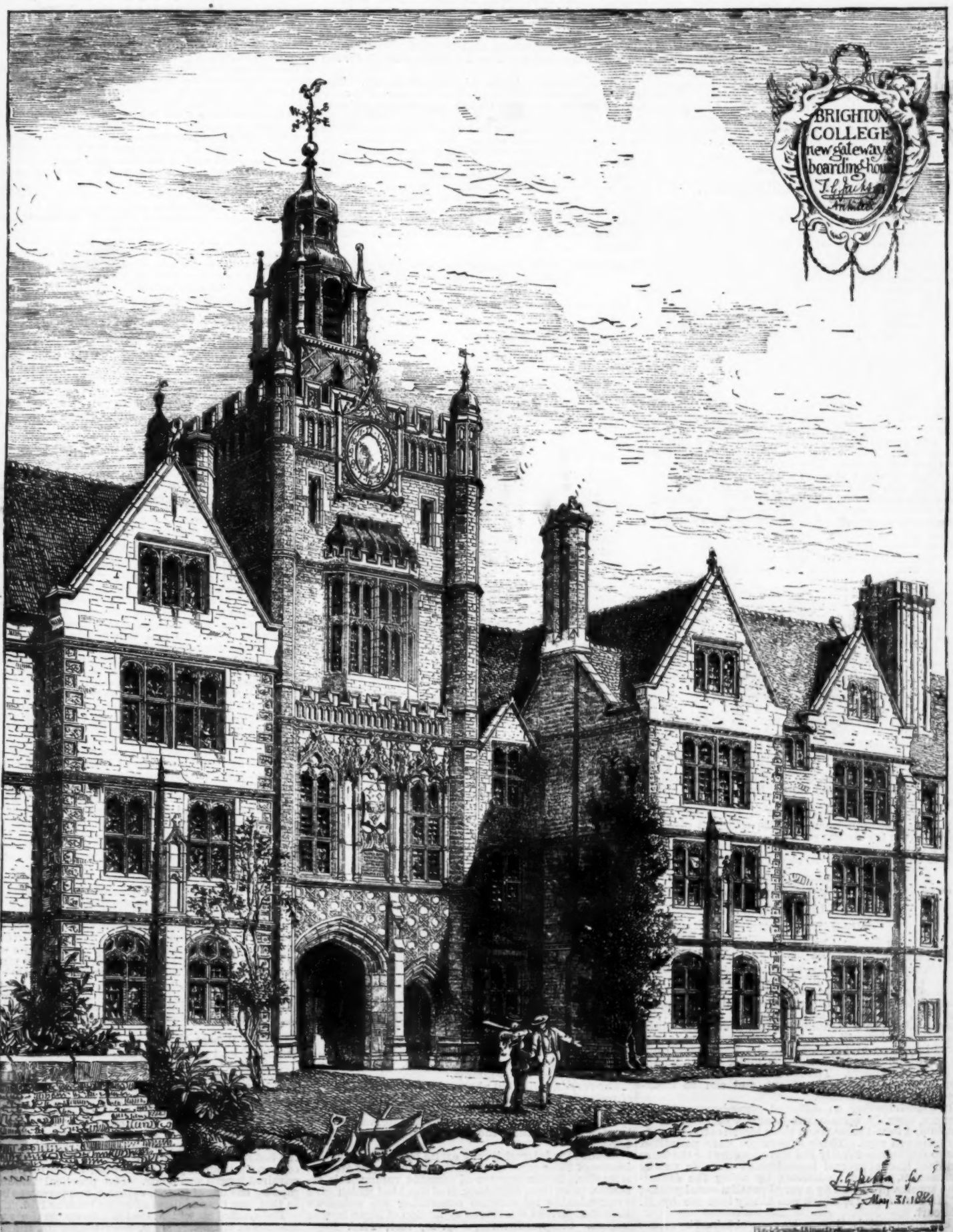
SCIENTIFIC AMERICAN

No. SUPPLEMENT 474

Scientific American Supplement, Vol. XIX., No. 474.
Scientific American, established 1845.

NEW YORK, JANUARY 31, 1885.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



SUGGESTIONS IN ARCHITECTURE.—BRIGHTON COLLEGE.

BRIGHTON COLLEGE.

BRIGHTON COLLEGE was founded about the year 1846, and a building was provided for it by Sir G. Gilbert Scott, then Mr. Gilbert Scott, shortly after its establishment. Subsequent additions have been made at various times, and especially within the last few years, by Mr. T. G. Jackson, who is now the architect to the college. Under his direction the playground has been leveled, and a cricket pavilion built. A new boarding house, to contain 40 boys, is just completed ready for occupation, and the foundations of another similar boarding house, together with those of the entrance tower, shown in our illustration, have been brought up to the surface of the ground. Plans are also prepared for a new chapel, a laboratory, and a gymnasium, to replace existing buildings, which are inadequate to the requirements of the school; also for additional classrooms and a great hall, the want of which has long been felt. These buildings, together with two more boarding houses, will eventually form three sides of a large quadrangle, of which Sir Gilbert Scott's building will form the fourth. In the college chapel a number of monuments have lately been erected, from Mr. Jackson's designs, to distinguished pupils of the college, among others to Mr. Margary, who was murdered in Western China while engaged on public service, and Captain Gill, who shared the fate of Professor Palmer in Arabia, at the beginning of the late Egyptian campaign. Mr. T. Griffiths, of Brighton, has been the contractor for the boarding house just completed, and Mr. Mockford the clerk of works, under whom the present works are being carried out without a contractor.—*Building News.*

MINERAL ACIDS IN SOLID FORM.

THE danger which is connected with the carrying of liquid mineral acids to any distance, and the high freight expense it involves, have induced Dr. H. Gruneberg to look for a method of putting these acids in solid form, so as to make them more easily transportable, and to do away altogether with the risk of the danger of breakage. Thus English sulphuric acid used by the petroleum refineries of Roumania was advantageously replaced by solid anhydride. It was also tried to make liquid acids to be absorbed by porous indifferent bodies. Kieselguhr (infusible earth), which is found in almost inexhaustible quantities in Luneburg, was found to be the substance most adapted to absorb and retain mineral acids in quantities relatively considerable. After being deprived, by drying, of about 15 per cent. of moisture which it contains on the average, kieselguhr can absorb from 3 to 4 times of its weight of sulphuric acid at 66°, and twice its weight of muriatic acid at 20° B., and nitric acid of 36°. No difficulty is found in the operation. The silicious earth is dried and passed through sieves, then taken into a shallow wood, iron, or stone vessel, and the acid is added in a thin stream. The mixture is well agitated, and the lumps which at first form are broken up. The apparatus now used for the manufacture of superphosphates can be used for this process. The obtained product may be sieved. The sulphuric acid thus changed into solid form attracts moisture very quickly, and has to be therefore packed at once. For packing, lead-lined sheet iron vessels are used which are closed hermetically and soldered. Petroleum vessels can also be used, which are covered internally with a layer of gum lac.

Sulphuric acid solidified as above can find application in the form of a dry powder in several branches of industry, such as the refining of petroleum or of the fat oils, in the manufacture of dynamite, in stearine works, in the manufacture of carbonic acid for aerated waters (it is exported in large quantities to India for this purpose), in the manufacture of superphosphates, and of sulphate of ammonia, etc. In these cases the acid powder is put into direct contact with the substance to be treated, such as raw petroleum, glycerine, powdered phosphate, carbonate of lime, etc., and is then diluted by the addition of water to the degree of concentration required for the operation. In those cases in which only the acid in the liquid state can be employed, such as for metal ores, etc., the acid can be previously liquefied by being placed, together with water, in lead-lined tanks, the remaining powder being then separated from the liquid by means of filter presses.

The high cost of transportation of the liquid acids may render the application of this solidified product convenient in far distant countries, but in Europe it is most likely that manufacturers will not see any advantage to be derived from the use of these solid acids.

THE INFRA-RED EMISSION SPECTRA OF METALLIC VAPORS.

By H. BECQUEREL.

LAST year I submitted to the Academie des Sciences a short account of my first researches on the infra-red spectra emitted by metallic vapors, till then unknown.* Since that time I have investigated the subject still further by making use of a special spectroscope, which shall be described in a future paper. I will simply mention here, that the method consists in throwing the spectra about to be examined upon a suitable phosphorescent substance, which has been previously rendered luminous, and in observing the temporary excitation which precedes extinction under the influence of the infra-red rays. The lines and bands of the emission spectra then appear brilliant, and can be examined with the microscope.

In experimenting on different phosphorescent substances, notably certain preparations of sulphide of calcium, I found some much more sensitive than others for infra-red rays. These substances have permitted me to determine directly the wave lengths for the more brilliant lines of several incandescent metallic vapors (potassium, sodium, cadmium), by using the diffraction spectra produced by a very beautiful metal grating of Mr. Rutherfurd's, which was kindly lent me by M. Mascart.

For other metals, the spectra were obtained by means of a bisulphide of carbon prism. The positions of the lines were referred to those of the potassium and sodium lines, and to the positions of the bands and characteristic lines in the infra-red region of the solar spectrum, as well as the absorption bands of samarium; the wave length for each line was then determined by interpolation with great accuracy.

The wave lengths for the lines and principal bands in the infra-red of the solar spectrum have been again determined by means of the grating, which had been placed at my service; and the more sensitive substances in my possession have permitted me to extend these measurements much further than I was enabled to do in my previous researches.* I propose to return shortly to this work, which has led me to rectify several numbers relating to wave lengths at the less refrangible end of the spectrum; I will only give here the wave lengths of the principal lines used for reference: the band indicated by A^c in my former memoir is made up of two bands, whose wave lengths are from 0·00115 to 0·00119 millim., and from 0·001132 to 0·001142 millim.; the large band A^3 extends from 0·001351 to about 0·001400 millim., and the extreme band A^4 from 0·001800 to about 0·001900 millim. The wave lengths of the characteristic absorption bands of samarium, directly determined, are: from 0·001079 to 0·001097 millim. for the first, and from 0·001239 to 0·001267 for the second.

The metals were volatilized in the voltaic arc. The intensity was such that I could make use of a very narrow slit, and observe, on the phosphorescent substance, interesting details. In this case, it is necessary that the image of the line be brought to an exact focus on the phosphorescent screen; for, unless this be so, the results are not observable when the slit is narrow. I have not yet been able to invent a suitable arrangement for giving a complete and definite image of the whole of the infra-red spectrum; but, by repeated trials, it was possible to obtain sufficiently distinct images of the group of lines which are to be examined. I am occupied, however, at the present moment with an improvement which will admit of still greater delicacy.

Wave Lengths of the Principal Emission Rays of Several Incandescent Metallic Vapors.

POTASSIUM.

Wave length.

770, 1098, 1162, 1233 — Lines very brilliant.

SODIUM.

819 — Visible to the naked eye. Capt. Abney has photographed this line, and discovered that it is double.

1142

STRONTIUM.

870, 961, 1003, 1034, 1098 — Lines and bands feebler; approximate wave lengths.

CALCIUM.

858–876, 883–888 — Broad bands, probably groups of lines.

MAGNESIUM.

809 — Very intense, perhaps compound.
1047 (?) — Very feeble.
1200 — Broad, and perhaps double.
1212 — This group resembles group *b*.

ALUMINUM

1138, 1861·5 — Broad and intense, perhaps compound.

ZINC.

1125, 1306

CADMIUM.

1850.

LEAD.

1059·8, 1087, 1133 — Very intense.
1221 — Feebler group.
1229 — Approximate wave length.

THALLIUM.

1150. Approximate wave length.

BISMUTH.

837, 973 — Approximate wave lengths.

SILVER.

771, 895 — Visible to the naked eye.

TIN.

1083, 1199

The preceding table contains the wave lengths for the most intense lines, bands, or groups of lines which characterize the spectra of several metallic vapors. The numbers are expressed in millionths of a millimeter, and are generally exact to one or two millionths of a millimeter.

Nickel gave several rather feeble bands or groups of lines; while iron, in our experiments, gave no band sufficiently intense to examine.

The results, indicated above, show how rich the field of research is which the phenomena of phosphorescence open up in the invisible part of the infra-red of the spectrum, and which, alone, covers an interval of wave lengths greater than the visible and ultraviolet parts together.

Besides the interest it may excite by proving the existence of these rays, of which the wave lengths are considerable, in the spectra of metallic vapors, this research, more than any other, is of the kind which give most valuable information concerning the unknown laws that govern the vibratory motion of incandescent vapors.—*Comptes Rendus, Aug.* 25, 1884; *Phil. Mag., Oct.*, 1884.

* Comptes Rendus, t. xcvii. p. 71.

* Annales de Chim'e et de Physique, 5 serie, t. xxx. p. 5.

LEAD: ITS PROPERTIES AND USES.

By ALEX. W. MURRAY.

IT occurred to the writer, when reading the questions submitted at a recent examination in plumbing, of the city and guilds of the London Institute, published in *The Sanitary News* on October 1, that answers to them would be appropriate matter for your columns; if the answers here given are not what they should be, you can find more room for them in the waste basket than in your valuable paper. Literal answers will not be given to each question, but the subject upon which the question is based will be treated as concisely as the ability of the writer will permit; each answer will form a topic by itself, appearing (if worthy) at regular intervals.

It is the duty of plumbers to acquire a knowledge of the chemical and physical properties of metals, especially of those used in their trade, in order that they may be able to judge which metal is best adapted for use in the several appliances in the trade, both as to their durability and freedom from corrosion. The cheapness of books and the great number of authors to select from, upon any special subject, brings knowledge within the reach of all who may seek for it. The lack of systematic reading is a prominent feature in our trade. Is it not a pleasure and a source of profit to know the reason why *this* or *that* acts *so* and *so*? Or to know *why* and *how* you should do *this* or *that*? Or to know when, where, and by whom anything was made? My readers, God has given you a mind to use, and you will be held to a strict accounting for the use you put it to. You can best serve your Master and fellow-man by being an intelligent worker in the vocation you have chosen.

Question No. 1 asks to describe the principal physical properties of lead. Lead is a part of the mineral division of the earth, being an elementary body. It is opaque, a better conductor of electricity than of sound, than of caloric; and it is of a bluish gray color, having a glimmering metallic luster while in the condition of pig, pipe, sheet, or hot; but when free from oxidation, as when cut or shaved by a knife or plane, it has a glittering metallic luster, near akin to that of nickel; and when examined under sun, electric, or gas light, it possesses the property of refracting the rays of light, producing the seven primary colors upon such bright surface. It is the least elastic and sonorous of all the metals. These properties are exemplified in target practice and the manipulating of the metal in the art of plumbing. Being malleable and laminable, it can therefore be hammered or rolled into thin plates. It is fusible and melts at a temperature of 612 degrees Fah., and can be alloyed with many metals. If three parts are combined with five of bismuth and two of tin, the alloy can be melted at a temperature of 212 degrees, the heat of boiling water, and is therefore naturally the best adapted metal that plumbers could have adopted for the various uses it serves in their trade. Though it is not very ductile, in fact being the least ductile but one (nickel) of all the metals, it can be pressed while in a partially melted condition into any shape—wire, tube, or sheet. It is crystallized by hammering and bending. To this property can be charged the cracks or breaks that are often met with in waste-pipes that have been indented or buckled, or in that portion of hand-made traps where the greatest number of blows have been struck in forming the trap. I reason in this manner: The metal being crystallized by the hammering, it is more readily oxidized (by the assistance of air and moisture) at these points than the rest of the pipe or trap, from the facility by which the air and moisture can get at each atom of lead, on account of such crystallization. When melted and slowly cooled, it forms octahedral crystals. To this property the writer ascribes the cause for the leakage of soldered joints, made in connecting the kitchen boiler with the heater or water-back of the kitchen stove. The joints being overheated during ironing or baking, the metal is crystallized, and in time becomes so porous that water easily passes though it. This trouble can be avoided by letting the hot water occasionally flow at the sink.

Although lead, in many instances, has been found in a native state, it is more generally discovered as sulphuret of lead. This is known in commerce by the name of galena. Knight says lead was known in old times. "They sank as lead in the mighty waters" is a part of the triumphant song of Miriam, 1491 B. C. Job refers to its use for writing-tablets—"an iron pen and lead." "A work of Hesiod's was preserved for many centuries stretched on leaden tablets." Iron, tin, and lead were enumerated by Ezekiel as among the commercial objects of the Tyrian trips to Tarshish. The Romans used sheet-lead largely in making water-pipes. Lead was probably the first metal worked, because its ores are abundant in all countries, and it is frequently found at or near the surface of the ground, rising at so low a temperature of 612 degrees Fah. The discovery of melted lead must have attracted the attention of the ancients at an early day, while building fires in the mineral districts. Ewbank relates that the terraces of Nebuchadnezzar's hanging-gardens were covered with sheets of lead soldered together to retain moisture in the soil. Archimedes used lead pipe to distribute water by engines in the large ship built for Hiero. The plumbers of Pompeii used lead pipes, for we read that the Neapolitan government sold large quantities of "leaden" pipes as old metal. Plumbing is, therefore, no new art, but among the earliest of which we have any record. Rolling or milling lead was invented by Thomas Hale in 1670.

In 1538 Robert Brocke was the first to cast short lengths of lead pipe, by the use of moulds. The lengths were jointed together by a process of burning. A native of St. Germain, in the reign of Henry the IV. of France, invented a process by which the pipe could be made any desired length, as follows: The mould was placed in a horizontal position, the metal poured in on top near one end, and, when cast, was drawn out; only one or two inches were left in near the spout where the metal entered, so that when another length was cast the hot metal would melt the end thus left, and become a continuous part of the pipe, and so on until the required length was made. The practical making of pipe by the use of piston, cylinder, and press was begun in 1820, but it was talked of as far back as 1705.

The symbol by which lead is known in the mathematics of chemistry is Pb, from plumbum, the Latin name of lead. These letters are used to prevent confusion. The natural inference is that L would be the most appropriate abbreviation, but L is the symbol of

lithium. The proportion by weight (*chemical equivalent*), in which it unites with other elements, is 103·6. Its specific gravity being 11·44, it is therefore eleven times heavier than water. This makes it available for use in sounding-leads, in ascertaining the depths of seas and oceans. We learn the following from Steele: From it are made litharge, used in the manufacture of glass, in paints, and as a glaze upon earthenware, oxide of lead (PbO), red-lead, minium (Pb_3O_4), used in coloring sealing-wax, as a paint, and by plumbers, steam and gas-fitters, as a luting in joining pipes, and white-lead—carbonate of lead (PbO,CO_2).

Lead is corroded by the assistance of acetic acid (vinegar). Care should be taken in vinegar and pickle factories to have thicker lead used. We are informed that soft or rain water, when aerated, silt of rivers, and vegetable matter (in a state of decay), will oxidize lead; also, that pure water, assisted by oxygen, and sewer-gas, are enemies to lead. We know it can be turned into dross by heat. Nitric acid is the proper solvent for lead, producing whitish opaque crystals of nitrate of lead. Comparative freedom from lead poisoning can be attained by workers in lead by cleanliness of person, taking regularly warm baths, seeing to it that the fumes while melting are properly carried off, and changing the working apparel when done with the day's work. In the matter of diet, drink plenty of fresh milk and eat fat mutton, and as medicine consult your physician, although an occasional dose of Epsom salts would not hurt you. Steele gives the following test for the presence of lead: Hydrosulphuric acid (HS), which forms with the metal the black sulphuret of lead (PbS). A very comical illustration is as follows: Thicken a solution of sugar of lead (PbOA) with a little gum arabic, so that it will not flow too readily from the pen, and draw some comical figure upon paper. This, when dry, will be invisible, but when dampened on the wrong side and passed over a jet of HS the picture will blacken into sight. The Franklin Institute officially declared, in 1870, that there exist no authenticated accounts of the health of the numerous towns and cities supplied by leaden distributing pipes having been injuriously affected. Samples of lead pipe two hundred years old were submitted to the French Academy, which showed so little corrosion that the impression of the sand of the mould in which the pipe was cast was distinctly visible.

"Are lead service pipes safe? How often this question is asked, and for want of an intelligent reply, how much nervous anxiety caused, as well as needless expense! We answer, yes, especially in the West, where all the water contains so much carbonate of lime. This was demonstrated, a few years since, by the very intelligent head of the water department of Paris, France. He took up lead service pipes that has been in use for hundreds of years, and found no change in the interior or exterior surfaces and no loss in weight. He stated that where lime, even in very small quantities, was present in the water, there was quickly formed a coating on the inside of the pipe that entirely prevented any further action of the lead upon the water, and that there was always present enough of lime dust in the atmosphere of Paris to make it perfectly safe to use even the rain water, conducted through leaden pipes. There can be no question but that good pure lead makes the best service pipes for conveying water to and through our dwellings from springs and street mains. It is durable, lasting for generations. It is easily and rapidly laid, being pliable, and furnished in long coils. It is easily and cheaply repaired, requiring often the removal of only a few inches, expanded by frost, and insertion of a new piece, when a whole length of iron pipe would have to come out, at great cost and inconvenience."

Where used for supplying water, to guard against a possible chance of danger, one should let the water run until he is satisfied that the capacity of the pipe has been emptied.

Heavy lead soil-pipe, put up properly, in my opinion makes the best soil-pipe that can be used. To guard against its being eaten by rats, it can be bound with brass wire gauze.

In conclusion, the writer supposes the reason we plumbers are "leaden-heeled" and dull is, because we, in time, partake of the nature of the principal metal we work in, "lead." As a piece of advice to my brother "Chips," do not fuse your metal near the nostrils of your customer, lest you make him so dull that he may not see the justice of your bill, and be slow in paying it.—*Plumbers' Trade Journal.*

NEW FORMS OF SWEDISH HEARTH AND WELDING FURNACES.

By Mr. G. A. FORSBERG.

THE author describes a modification of the Swedish "Lancashire" hearth finery which has been introduced at the Skutskar ironworks. The hearth is of the rectangular form usual in Sweden, but differs from the ordinary construction in having a third tuyere, in the back wall, that opposite to the working or front side. The side walls are formed of hollow iron castings, which are cooled by allowing the blast to pass through them, whereby it becomes heated before arriving at the tuyeres. The hearth is covered by an arched roof of brickwork, carrying a hopper closed by a slide, in which the charcoal is charged and dropped into the fire as required, instead of the old plan of shoveling it in through the working door in front. The waste flame, on its way to the chimney, passes over a bed in which the pig- ron for the following charge is brought up to a strong heat before its introduction into the melting-hearth. A comparative trial of one of these hearths against one of the ordinary kind with two tuyeres, carried on for a period of four weeks, gave the following results:

The two-tuyere hearth produced an average of 265 cwt. of blooms per week, with a consumption of 5⅛ bushels of charcoal per cwt.

The three-tuyere hearth produced 366 cwt. per week of bloom-iron, with a consumption of 4⅞ bushels charcoal per cwt.

The loss in the metal in working was about the same in both cases, namely, 12·93 per cent., or 1·1485 cwt. of pig-iron were required to make 1 cwt. of bloom-iron.

The author suggests a method for further increasing the production of this class of furnace, by doing away with the melting of the pig-iron in the refining hearth. For this purpose the heating-bed for the metal in the flue is to be converted into a melting-bed, which is kept warm by the waste flame during the actual firing period, and receives the heat necessary for melting from a gas producer, placed at right angles to the working axis of the hearth. This arrangement is figured in the plate illustrating the paper. Two hearths, placed back by back, communicate with the same stack, and are served by a producer common to both. The gas being only required during the melting period, the producer is damped during the refining of the metal in the hearth. The gas-producer may be worked with inferior fuel, in which case the melting of the pig is done at less cost than in the fining hearth, where charcoal must be used.

The welding furnace described by the author is a gas-furnace, with a flat bed about 20 feet long, and low arch, standing within its own blast-heating apparatus, the latter being a series of short upright and horizontal pipes, the former being also part of the structural iron-work of the furnace. The horizontal pipes are placed below the bed, and correspond in some degree to the long horizontal air way in Bicheroux's furnace. The gas-producer has a stack 10 feet high, shaped somewhat like that of a charcoal blast-furnace, the bottom being closed by a grate arranged to work upon a central axis. The charging is effected by a gas-tight covered hopper and valves. The gas passes by a siphon up-take and down-come within the same mass of brickwork as the stack to a chamber forming the ashpit of the furnace, where it meets the heated air in jets from a square pipe in the roof, a short distance in front of the fire-bridge. The producer is worked with waste short ends of deals and planks, previously dried at 104° to 150° Centigrade, the consumption being equivalent to 2·7 bushels of charcoal, supposing the wood to be equal to 63 per cent. of the latter. The loss upon the blooms heated for rolling into merchant iron was 11·5 per cent. A further modification of this furnace is provided with two similar gas-producers, which are worked alternately, the fuel charged wet in one being dried while the other is being converted into gas. For the former purpose the gas delivery passage is closed by a valve at the bend of the gas delivery siphon, and the charging-valve of the hopper is opened while heated air from the hot-blast tubes is passed through the wet wood from below, until hygroscopic water is converted into steam.—*Jernkontorets Annaler, through Proc. Inst. Civ. Eng.*

THE THEORY OF BLAST-FURNACE SLAG REFINING.

By A. D. ELBERS.

BLAST-FURNACE slag and glass are both amorphous mixtures of silicates. As glass is a perfect, and slag an imperfect, mixture, a comparison of their behavior under like treatment may lead to a better understanding of what can be done to redeem the slag from its scoriaceous nature.

When liquid melted glass is cooled slowly, it becomes pasty before it solidifies; when glass is remelted, it again changes to the semi-fluid condition before absolute liquefaction sets in, and when devitrified glass is remelted, it liquefies suddenly.

When a stream of liquid slag is tapped from the blast-furnace it is of dazzling white color, but the latter turns readily into orange and red, because the slag cools and solidifies rapidly on the surface. When the flow of the stream becomes sluggish, the slag seems to be in the semi-fluid or pasty condition in which glass can be spun out mechanically into continuous threads. This appearance is, however, fallacious, for the semi-fluid glass is of the same consistency throughout the mass, whereas the sluggish slag consists of already solidified particles which are embedded in other still liquid particles, and as the latter solidify the whole mass becomes suddenly stiff. When such an incongruous mass is remelted, it passes suddenly from the solid to the liquid state.

When a stream of liquid melted glass is subjected to the impinging force of a strong jet of steam or air, it is torn asunder into quick-chilling particles, which flatten out into rather uniform thin scales. When liquid and not too calcareous blast-furnace slag is subjected to the same treatment, the disjointed but still partly liquid particles change into short fibers and globules which intermix in settling, and the voluminous mass which is thus obtained is called slagwool. The fibers are spun out immediately upon the detachment of the slag particles from the main body of the stream, just as liquid slag can be squeezed out of a partly solidified or apparently semi-fluid mass, and are mostly the direct issue of one silicate out of another. This tendency of liquid melted masses to rearrange themselves into more definite compounds while they have the freedom of motion; is characteristic of all imperfect compositions of silicicalcareous minerals which, like blast-furnace slag, have not been kept long enough in the liquid state to become more perfectly assimilated.

That the investigation of slag is less difficult, after the latter has been reduced to slagwool, is evident. Slagwool is sometimes white as the driven snow, but if it contain sulphur, it can be remelted into dark, bad-looking scoria just the same as if slag from the cinder bank were remelted. Sulphur can exist in different or allotropic forms; its combinations with other ingredients of the slag undergo similar changes of form, partly by oxidation and deoxidation, while the liquid slag is exposed to the blast, and partly by disintegration in the slagwool, while the latter is already solid, but still red hot. When the cooled slagwool is reheated quickly to a temperature of about 1,800° F., the sulphur exhibits great inclination to return to its former state, the sulphides melt, and the rest of the mass is thereby impelled to reunite chemically, which leads to its sudden fusion, when the heat is slightly increased. If the slagwool has been compressed to a proper density, and is then reheated in such manner that the atmospheric air can gradually enter the mass, expel sulphur, and thereby set other impurities free, the fibers become readily decomposed, while the interspersed globules remain unchanged in form; the decomposed mass subsequently reunites without fusion into a soft, loosely fritted mass, just as silicates are formed by merely fritting their constituents together.

The bisilicate and more acid slags are deficient in sulphur; their slagwool is very coarse, and the fibers become irregularly disintegrated in roasting. A small percentage of volatilizable sulphur therefore seems necessary for that thorough decomposition of the mass without which no recombination into more homogeneous compounds can take place.

The soft or reduced mass of the roasted slagwool can be separated from the globules in leaching and washing, and the globular part can be purified in the same manner, after it has been pulverized and roasted over. When either mass has been purified to such an extent that it is insoluble in water, it may then be called refined slag, provided that in melting it will change gradually from the solid to the liquid state.

If the slagwool is made from subsilicate slags, many constituent parts do not recombine in roasting, or become soluble in water; these defects are lessened in the measure in which the oxygen ratio of the silicic acid is nearer to that of the combined bases, counting alumina as a base. When silica is in excess, the slag is apt to contain ferrous and manganous silicates, which impart to the refined slag a slight tinge of rose or cream color, and when alumina is in excess, nearly all ferruginous impurities are in complete solution or chemical combination with the slag, which will then retain a darker color in the refined state.

Alumina is acid in the formation of the singulo-silicate slag; in slowly cooling slag it may be assumed to turn basic up to certain proportions, which can be construed to remain within the limits of an equal oxygen ratio of acid to bases (1:1) or do not exceed the ratio of 1½:1, if it is counted on the acid side. In many slags, in which the percentage of alumina is nearly in accord with either formula, the sudden change from acidity to basicity is probably influenced by simultaneous changes in the atomicity of oxides of sulphur or iron. In whichever manner these slags may become chemically affected, it is known that they can be vitrified by sudden chilling, whereas they become opaque or stonelike in cooling gradually, and that the vitrified kind can be reduced to the latter condition by annealing.

As all the chemical changes in the slowly cooling slag lead to scorification, or sudden fusion, in reheating to that temperature at which sulphur can be expelled, the prevention or even interception of these changes must leave the slag in a much better condition for roasting. This is accomplished by thorough chilling, which can best be attained by flushing the slag, or by causing it to spread, into very thin layers, in order to expose the greatest possible surface to aeration. If such slag is pulverized and then roasted, its reduction may progress more slowly than that of slagwool, but will be so uniform that the mass can be fritted quite dense or compact without the least scorification. After the sulphur has been expelled from the mass, the latter is still in the loose-fritted condition, in which it can be purified by the wet process.

The conversion of liquid slag into slagwool allows of producing distinct grades of refined slag from the same raw material; the undivided composition of the chilled slag has to be reduced in one operation to a uniform mass. The former method yields the most valuable qualities, whereas the latter is cheaper, and therefore better adapted for putting blast-furnace slag into competition with the natural substances which are used in vast quantities in the manufacture of cements. As the results differ only in degree, the final conclusions on slag refining may be arrived at without special reference to either method.

The basic condition of alumina in refined slag cannot be changed to acidity below complete fusion of the mass, unless the latter is roasted in intimate contact with some intermixed substance for which alumina has great affinity, as for lime which has just been reduced from the carbonate. In such admixture it is easily converted, and the silica, which is thus set free, is then also in a condition to combine most readily. As many slags contain alumina and silica in such proportions that the proper composition of artificial Portland cements can be attained by the addition of lime only, it seems quite practical to manufacture cements in that way. The roasted slag can be more readily converted into cement than the much more refractory natural silicates of alumina, and contains already so much lime that less than its own weight of chalk or limestone need be added to the charge. Other roasted slags which contain but little alumina can be used in the manufacture of glass, after having been purified by the wet process.

The fusion of the glass composition is quickened in the measure in which sand and earthy bases are replaced with refined slag in the usual proportion of constituents. Under the trisilicate formula for glass, the substitution of singulo-silicate slag is feasible to the extent of from about ten to twenty-five per cent. of the weight of the composition. The use of refined slag in such proportions is either equivalent to a saving in heat and time, or to a saving in alkalies, borax, oxides of lead and zinc, and also to an improvement in quality, inasmuch as the diminution of these other ingredients renders glass more enduring, physically and chemically. This improvement is especially desirable in pottery glazes and enamels.

Refined slag can be fritted hard, melted opaque, and melted transparent or glass-like, at temperatures corresponding respectively to light red, ordinary white, and full or perfect white heat; it is more fusible than orthoclase feldspar, and a mixture of both substances can be melted into a transparent flux at a still lower heat.

True porcelain can, however, be made from pure China clay or kaolin and refined slag without any other flux, these materials being wet-mixed, formed, air-dried, and subjected to the hard porcelain fire in the usual manner. If the refined slag melted suddenly or became quite liquid, the body in which it has been incorporated would collapse, and if it were not melted into transparent glass the body could not be translucent, because a kaolin body without flux will remain opaque after having been subjected to the most intense heat.

Having thus considered the most important changes of refined slag, the various uses which it is destined to find in the arts and technical industries can probably be deduced from the following definition:

The refining of slag means to purify the slag without destroying its peculiar silicate constitution, which is that of a singulo-silicate, having usually several bases. The peculiar properties of these singulo-silicates are solubility in strong acids and partial decomposition in the caustic hydrates of lime and alkalies, easy combination in fritting with other substances, and energetic saturating capacity in the melted state.

Hoboken, N. J., December 22, 1884.

SAND SOAP AND TRANSPARENT SOAP.

THE following are abstracts from the *Seifensieder Zeitung* given in the *Journal of the Society of Chemical Industry*:

SAND SOAP.

Under the name of sand soap a new detergent of peculiar appearance and composition, of English origin, has been recently placed upon the market. It is grayish white in color, heavy as stone, and rough and sandy to the touch; on rubbing the hands with it, particles of sand adhere to the skin. It is, in fact, an intimate mixture of fine sand with ordinary soap. In order to ascertain its composition, the writer has subjected it to analysis, and finds it to contain 70 per cent. of fine sand; the saponified fat was palm oil. Experiments showed it to have no disagreeable or damaging effect on the hands when used as a detergent, and proved it, moreover, to be an excellent cleansing soap, especially suited for the use of workmen engaged in rough and dirty vocations. The author has made various experiments with a view to ascertain the maximum amount of sand which a soap of this kind can take up, and finds that 100 parts of soap can take up 200 parts of sand, but it is not advisable to add the full quantity, as the mixture will no longer lather properly. To make a good "sand soap," the author recommends the following method: One hundred lb. of cocoanut oil are saponified with about 200 lb. of lye at 20° B. The soap is then hardened by the addition of about 8 lb. salt dissolved in water to a density of 15° B., with the addition of 6 lb. to 8 lb. soda ash. The soap is now covered up, and the foam allowed to subside. After standing five to six hours, the fob is skimmed and the soap is run off into the coolers. While this process has been going on the sand has been dried and sifted, and the soap now being thoroughly crutched, the sand is sifted over it until 100 lb. to 150 lb. have been added. The crutching must be continued until the mass is perfectly cooled. The soap is very firm and hard, and must be cut as soon as cooled. To perfume the mixture add of essential oil of lavender, thyme, and coriander 100 grammes each.

TRANSPARENT GLYCERINE SOAP.

The manufacture of transparent glycerine soap does not present any special difficulty; there are nevertheless points which it is essential to observe. To produce first-class soap of this kind good materials are indispensable, and the proper proportions must be strictly adhered to. Tallow and stearine are the most useful hard fats, palm oil imparts to the soap its lathering qualities, and castor oil gives transparency. Great transparency is attained by the use of spirit and of sugar-water, both of which bodies assist the normal saponification. The lye must be pure, and clear as water; its proportion should not exceed 20 per cent. of lye per lb. of fatty matter, for an excess of alkali would make the soap too detergent, and a considerable excess of unsaponified fat would make it too weak and greasy. In one case the soap injures the skin in use, in the other the soap would soon lose its agreeable smell, and finally become rancid. Even an excess of glycerine is to be avoided, as it renders the soap less transparent, and also too soft. No filling whatever except sugar solution is permissible. The following proportions are recommended:

WHITE ALABASTER SOAP.

	Lb.
Stearine	13
Palm oil	22
Glycerine	13
Thirty-eight degrees lye	18
Ninety-six per cent. alcohol	26

The stearine and palm oil are to be heated to 65°, saponified with the lye, the alcohol added, and when the combination, which takes place at once, is complete, the glycerine is put in. When clear, the kettle is covered, and the contents are allowed to stand at 45° R. The soap is run into the moulds, and perfumed with:

	Grammes.
Bergamot oil	120
Geranium oil	30
Neroli oil	25
Citron oil	30

As this is a white soap, no color is added.

TRANSPARENT GLYCERINE SOAP.

	Lb.
Tallow	20
Palm oil	12
Castor oil	8
Thirty-eight degrees lye	20
Spirit	20
Glycerine	20
Sugar dissolved in	5
Water	5

Process as above. Perfume with oil of bergamot, 250 grammes; citron, 90 grammes; lavender, 20 grammes; neroli, 30 grammes; rosemary, 5 grammes; and a few drops of otto of roses, dissolved in 1 lb. of 96° alcohol; color with saffron substitute.

THE MANUFACTURE OF CANDLES.

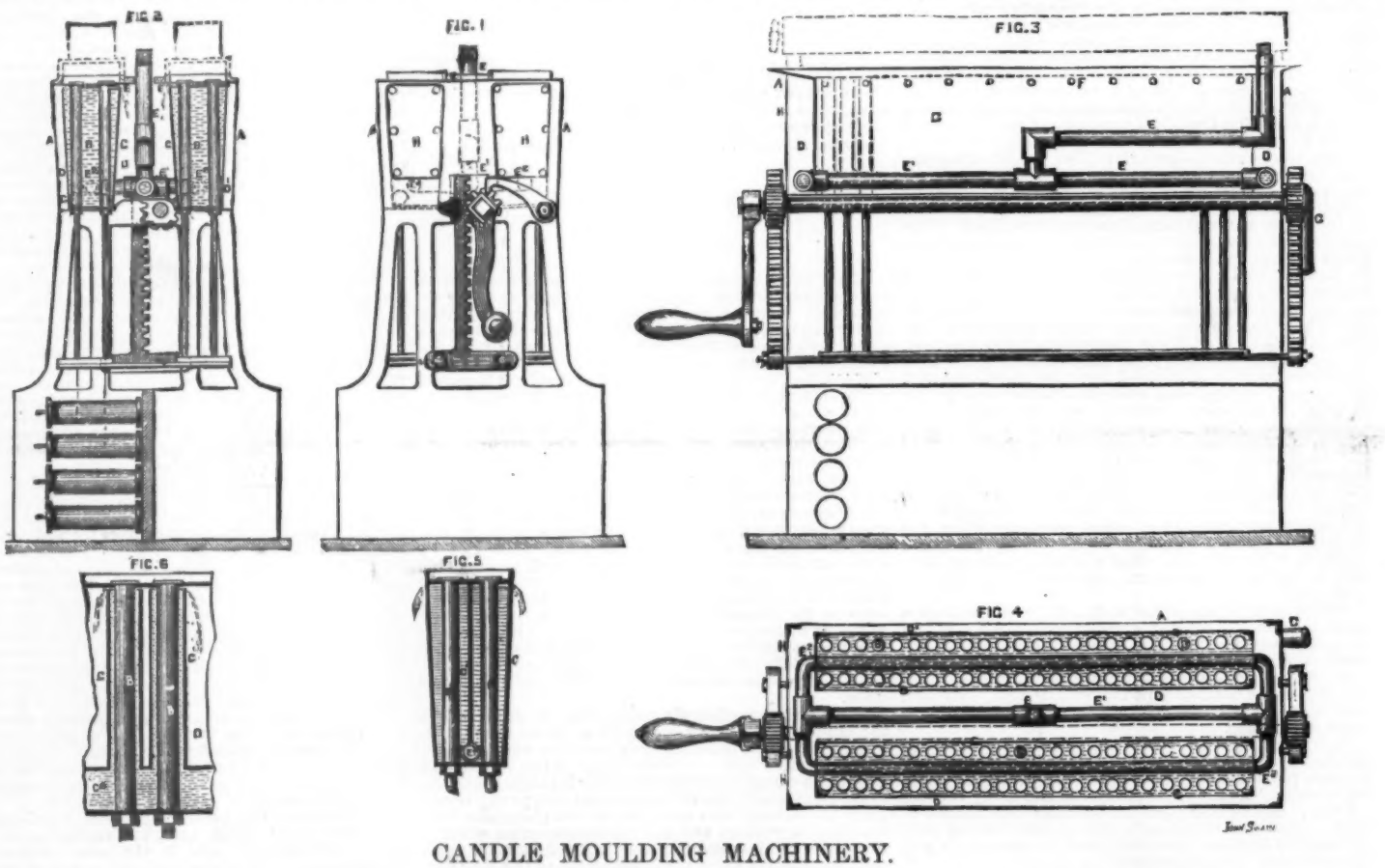
THE chief and oldest department of the candle works of Messrs. Field and Co. is in Lambeth Marsh, at the back of St. Thomas's Hospital, and a few minutes' walk from Westminster Bridge, London. The firm has existed from time immemorial, its origin being lost in the dim mists of antiquity; and it has supplied the Court, the Houses of Parliament, and the Archbishop's Palace at Lambeth with candles as far back as the records can be traced in the archives of the past. Six generations at least of the house of Field have successively enhanced the reputation of the firm, and how many more there may have been is a matter of research for the antiquary. Who was the original Mr. Field is thus unknown. He was probably one who had an earnest desire to lighten the darkness of the world around him, and to derive an honorable income for himself in the process. As the centuries rolled on, the firm waxed—if the expression may be allowed—waxed mighty until it has attained its present altitude. Not alone have the official representatives of the nation been faithful to the house of Field; some of the old county families—who abhor new-fangled things, such as gas, electricity, engineers, and railways—still purchase their wax candles of J. C. and J. Field and Co., and burn them, as their forefathers did before them. To such, stearine displays its attractions in vain, and paraffine is an abomination for the additional reason that it has usurped the ancient name of wax. Besides, your connoisseur knows the real, old-fashioned wax candle from the English or American imitation. The smell and color are partially guides, but more especially the series of rings seen, as in the stem of a tree, when it is cut transversely, each indicating the superfusion of an additional layer of the material. The present representative of the name, Mr. Leopold Field, F.C.S., has made original researches on the chemistry of the oils and paraffines. He delivered a series of lectures, about eighteen months ago, before the Society of Arts, on illuminating materials, and these lectures displayed high scientific ability and classical knowledge. His father, Mr. Frederick Field, is a Fellow of the Royal Society and of various other learned bodies. He was for some years Her Majesty's Vice-Consul at Chili. His researches on the mineralogy, determination, and estimation of copper and silver have extended scientific knowledge in relation to these metals and their sources of supply.

The oldest account books still existing of Messrs. Field date back to about the year 1700, and some materials which are at least two centuries old have been found on the premises. Wax was bleached in the establishment in 1760, and as this operation requires bright sunshine and pure air, the atmosphere of London must have differed then from its present condition. The earliest member of the firm of whom there is any record was Thomas Field, who died in 1716. Fifty years ago the premises were surrounded by fields, dotted here and there with small houses.

Enough of the past; come we now to the present. The boiler house contains four boilers, the largest of the Galloway type; its dimensions are 7 ft. by 30 ft. The other three are Cornish boilers, and smaller than the Galloway. The chief function of these boilers is to supply steam for heating purposes, but a small portion of the available power is necessary to drive the various machines. Except in the boiler house, there is no fire in the factory. The four specialties of the firm are the manufacture of candles from spermaceti, stearine, paraffine, ozokerit, bee's, and vegetable waxes.

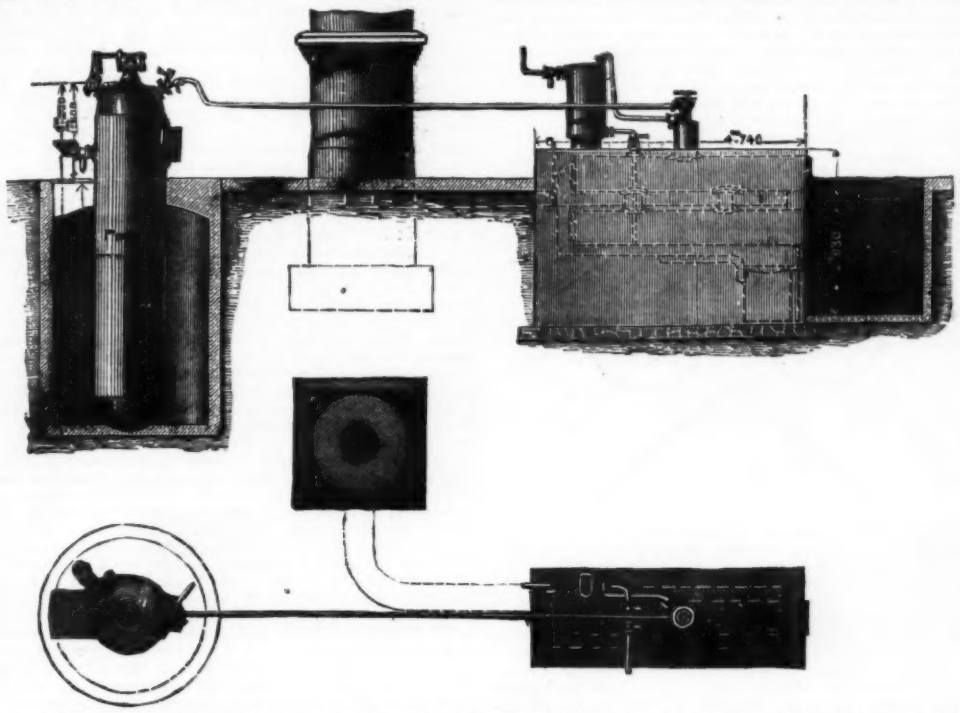
Chevreul's discoveries, which commenced in 1811, laid the foundation of the stearine industry; he first made known that the fats were not pure chemical substances, but compounds of a fatty acid with glycerine, and he continued his brilliant researches, in which he decomposed one fatty substance after another, until his scientific labors on the subject were finished in 1823. In 1825 he turned to the practical application of his discoveries, and with Gay-Lussac founded a factory for the commercial manufacture of stearine. It proved a commercial failure. The first to achieve success in a commercial sense by the adoption of Chevreul's discoveries was M. De Milly, who in 1832 commenced manufacturing stearine candles near the Barriere de l'Etoile, Paris. Since then the processes of manufacture have been improved by Wilson, Tighlmann, and others.

At Messrs. Field's works the mutton and beef tallows arrive in casks; their chief sources of supply are Australia and England, Russia no longer having the ascendency, which was once the case. The freight from Russia is more expensive, and the price of Russian tallow higher than the others, in about the proportion of five to four, at its selling rates in England. Tallow is a mixture of stearine and oleine, and stearine consists of stearic acid and glycerine; in fact, what are called stearine candles are in reality stearic acid candles, the glycerine having been previously separated because of its comparative uninflammability. The tallow when it reaches the works is dealt with either by the old "saponification" or more modern "high-pressure" process. The contents of the casks are steamed out into a great iron tank, into which, also, all the greasy dirt and refuse from the factory are thrown; palm oil is added, as well as a quantity of lime mixed with water, until it has the consistency of cream; about three-fourths of a ton of lime are added to five tons of mixed tallow and palm oil in this tank. The whole mixture is then boiled for four hours by means of steam, which enters through holes perforated in the bottom of the containing vessel. When the boiling is stopped the dirt sinks to the bottom, as well as the water, which now holds the glycerine in solution. This dilute solution is drawn off, and is technically known as "sweet water." The lime combines with the stearic, oleic, and palmitic acids, the mixed salts forming a substance technically called "rock." It has a cream color and a smell of the same odor as that of violets. The offensive smell of tallow is entirely absent. The "rock" is then transferred to a tank lined with lead, in which it is boiled for several hours with an equal weight to the lime of commercial sulphuric acid, technically known as "brown oil." This separates the lime in the form of sulphate, and leaves the fatty acids floating on the sur-



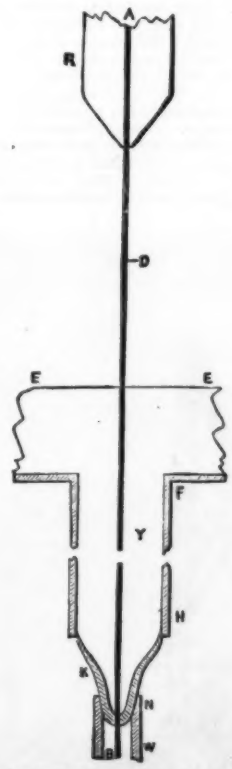
CANDLE MOULDING MACHINERY.

face. Thus a vast quantity of sulphate of lime—gypsum—is formed at the works in a pasty condition; and at present it is entirely a waste product, no means of utilizing the tons of it produced having been devised. The mixture of fatty acids is then run into rectangular tins, in which it solidifies into "press cakes," soft and brown. The same brown mixture is also produced on the premises by another process. The crude tallow and palm oil are put into a copper vessel, in which they are



MONS. P. MORANE'S APPARATUS FOR MAKING STEARIC ACID UNDER PRESSURE.

heated by steam, and subjected to a pressure of 170 lb. to the inch; about 2 per cent. of lime is previously mixed with them. A minute constant escape of steam through a tap enables the incoming steam to keep the contents of the vessel in constant agitation, without much reducing the pressure on the mass. After four hours of this treatment the separation of the fatty acids is complete. Two French elephant boilers are used to get up the steam, the advantage being that they can heat up rapidly. Steam blows the product over into the receiving tanks. The whole apparatus is represented in our engravings. There is always a little charring by this method; so the old saponification process gives slightly the best product. The product, by either process, after it has been cooled in rectangular tins, forms the soft brown cakes



SECTIONAL DIAGRAM.

already mentioned. The oleic acid is the soft one which it is now desired to separate. The cakes are next placed in horsehair bags, and with a piece of cocoa-nut matting between each bag are subjected for an hour or two to hydraulic pressure. This forces out the bulk of the oleic acid, leaving the cake harder, of a light yellow color, and with symptoms of a crystalline condition. The relative prices of oleine to stearine are as 30 to 50; so it is a great point to get rid as completely as possible of the former. The oil squeezed out is pumped into casks, for use in the manufacture of soap. Before this first pressing operation the cakes contain 50 per cent. of oleic acid; afterward they contain but about 10 per cent. The cakes are next placed in stronger bags, and pressed for an hour at a temperature of 90 deg. Fah. in an atmosphere of wet steam; the pressure is about six tons to the inch. Lastly, for the very finest stearine, white and crystalline, they are subjected for one and a half hours to a pressure of six tons to the inch, at a temperature of 140 deg. Fah. Perfectly pure stearine has a melting point of 159 deg. Fah., but this is never obtained in the manufacture upon a large scale. Some "distilled stearine" of foreign make is also used on the premises. This is made chiefly from palm oil by the "acidification process," in which the glycerine is charred by strong sulphuric acid, and the freed fatty acids subsequently distilled over in an atmosphere of superheated steam. The stearine is next melted into wooden tubs. In these tubs it is boiled by steam with a weak solution of sulphuric acid in water, in order to remove dirt and dross. Then it is run into cakes, which are stored for use.

The next operation is the moulding of the stearine or other substance into candles. The machine for doing this is of exceedingly ingenious construction, and is of comparatively modern invention. Its origin is, nevertheless, involved in some obscurity. Mr. Leopold Field states that, as well as he can ascertain, it was introduced into England from America, between 1848 and 1850. Since then there have been improvements in matters of detail, some of them patented by Mr. E. Cowles, of Hounslow, others by Messrs. Field. The accompanying sectional diagram will serve to explain the essential principle of the different varieties of machines. In this cut, A B is the wick, held in the center of the mould, F H, by the cold candle, R, and a bobbin below B, from which it is unrolled as required. Above the bobbin is a horizontal platform, which can be made to rise and fall vertically. This platform carries a number of tubes, the upper end of one of which is shown at N W. At the end of this tube is the mould of the tip of

CANDLE MAKING MACHINE.—PERSPECTIVE VIEW.

the candle, K. The mould of the cylinder of the candle is represented by F H. The melted stearine is poured into the top of the machine till it fills all the tubes, and moreover rises to the level, E E; its cooling is hastened by cold or tepid water flowing around the outside of the tubes. When the fatty acid is sufficiently cool, the wicks are cut at D, and the finished candles—of which R is one—removed. The platform below B is then raised, pushing up the candle-tip moulds, K, which rise like pistons in the tubes, F H, until the candles, Y, take the places of those removed from R—and so on for ever. The tube, F H, is a shade smaller at H than at F, which facilitates the expulsion of the candle. At each operation the machine makes from 80 to 100 candles, which, in the first instance, can be carried about on the stearine platform, E E, from which they are afterward separated, and cut to their proper lengths. The candle is thus bottom upward while being moulded. At one time there was much difficulty in preventing the stearine from crystallizing in the moulds, and Ure states that arsenic was actually mixed with it to prevent this. The difficulty is now overcome by the simple method of pouring in the stearine at as low a temperature as possible, and keeping it well stirred up to the moment of use.

The details of the latest and most improved form of the candle-making machine are shown in our engravings, and include some new modifications published in Cowles' patent of November 24, 1882. In these engravings, to use the words of the inventor, "Fig. 1 shows an end view of a candle machine, Fig. 2 shows a cross section, Fig. 3 a longitudinal section, and Fig. 4 a sectional plan. The general construction of the machine is similar to that of candle machines now in use, and need not be further described. In such machines, the casing, A, containing the candle moulds, B B, has heretofore always been entirely filled with water, as above stated; according to my present invention, I introduce into the casing two separate boxes or receptacles, C C, within each of which are contained two rows of the candle moulds, and these boxes alone are supplied with water, thus economizing the water that would otherwise fill the spaces, D, D^1, D^1. In order to effect a very uniform distribution of the water in the boxes, C C, the supply pipe, E, is led to the middle of the central pipe, E^1, in which it flows in both directions to the perforated pipes, E^2 E^2, in the lower parts of the boxes, so that the water issues simultaneously and with equal pressure along the whole length of these pipes into the boxes, and, after rising up in the same, overflows through openings at F into the outer casing, A, where it falls to the bottom, and is led off through one or more escape pipes, G. By this arrangement also the slide troughs and more or less complicated and expensive arrangement of overflow pipes necessary in the existing arrangements are dispensed with. In order to gain access to the interior of the boxes, C, for cleansing purposes, the one end or both ends of the casings, A, is or are formed with openings closed by covers, H, and the boxes, B, have similar openings closed by covers opposite to these, so that, on removing the covers, the interiors of the boxes are accessible. According to another modification, shown at Fig. 5, the boxes, C, are provided with a middle partition, C^1, the perforated pipe, E^2, being situated below it, so as to supply the water simultaneously to both compartments. Fig. 6 shows an arrangement in which each candle mould, B, is surrounded by a separate chamber or tube, C, all communicating at bottom with the space, C^2, into which the water is fed by the supply pipe communicating with each end thereof. The water, after rising in the tubes, overflows at the upper ends thereof into the space, D, of the outer casing, whence it is led off through an escape pipe."

One of the two perspective diagrams among our engravings represents a machine with modifications, invented by Mr. Lyon Field, for casting "ruffs" at the lower ends of candles, so that they will fit candlesticks of any size. Messrs. Field are the only manufacturers of this very popular description of candle, which necessitates the use of a mould made in two parts, otherwise

CANDLE MAKING MACHINE.—PERSPECTIVE VIEW.

the candle could not be removed from its temporary casing.

Professor Tyndall, who, in his Belfast address to the British Association, spoke of man as melting away like a summer cloud into the infinite azure of the past, probably derived the idea from the ethereal purity, the virgin whiteness of a Field's candle, by which he may have been writing; in fact, those who have never thought of taking the trouble to examine what can be done in the manufacture of ornamental candles have no idea of the beauty of some of the finished products, with their alabastrine translucency and, in some cases,

delicacy of color. In coloring candles, aniline and other organic dyes are used, care being taken not to employ any mineral or other coloring matter likely to be injurious to health when burnt.

Eosine gives a red candle; chlorophyl from the berries of the buckthorn gives a candle of a delicate green; the worst quality of stearine, that is to say, the stearine which has been least pressed, has a yellowish color, but turmeric is used for true yellow. Then the shapes of candles vary. There is the "cable candle," for instance, with its spiral exterior, made by turning it in a little machine, constructed on the same principle as that for rifling guns at Woolwich. The "Cleopatra candle," a *facsimile* of Cleopatra's needle, has hieroglyphics printed upon it. The printing of designs upon candles is effected by filling the mould with hot paraffine, then pouring it out again, so that but a thin film of the wax is left on the surface of the mould; the hieroglyphics, lettering, or designs, previously printed in on colors on a film of wax in a lithographic press, are then slipped into the mould; the wick is next drawn through, and the mould finally filled as in making an ordinary candle. In some candles a design is cut in an endless groove on the exterior; the candle is then again placed in its mould, and colored wax poured into the groove to form the design. The candles graduated with a design like that on a thermometer tube are made in this way. Aniline colors will not dissolve in paraffine, and are introduced into it by first dissolving them in a little stearic acid.

The object of mixing palm oil with tallow in the beginning of the process of making stearine candles is that it facilitates the pressing, doubtless because of differences in the crystallization of palmitic and stearic acids. The mixture of these two acids was once called "margaric acid," which is now known to be an undiscovered chemical substance. As a trace of olein materially lowers the melting point of stearine, it is of the greatest importance to free the acid crystals entirely from the oil; and the relative values of stearine and olein being as 50 to 30, a point of equal importance is to prevent the former passing away in the latter under the heat and pressure. Various patents exist for this purpose, but as yet no method has been discovered which yields results adequate to the expense of working.

The "sweet water" obtained from the first treatment of the tallow is evaporated down to a brown colored glycerine, which is used for making dynamite; in its brown state it will not do for soap, because of its smell. The effect of the recent legal restrictions on the sale of dynamite and nitro-glycerine has been to cut down the demand for the same for legitimate use; the price of crude brown glycerine has therefore fallen from £65 to £30 per ton.

About a hundred different wicks are employed on the premises, from the half-inch cable which is used in the largest-sized church candle to the tiny filament which burns in the night light. The size and substance of the wick, whether of cotton or flax, have to be proportioned to the hydrocarbon, or fatty acid, which is to be consumed. A substance containing a large proportion of oil needs a large wick to carry off the excess of liquid; also a very hard ozokerit or stearine candle requires a large wick to melt all the substance within the given radius. The two great defects to which a candle is liable are guttering and smoking—the former being due to too small a wick in a soft medium, the latter to too large and porous a wick, which feeds the flame too rapidly to insure perfect combustion and to raise the liberated carbon particles to a white heat. The true art of candle making lies in obviating these defects, and as no two parcels of crude tallow or paraffine are exactly the same in composition, the task is one of no little difficulty. By cunningly blending different brands of cotton and flax, increasing the porosity in one case by the removal of mineral matter with nitric or hydrochloric acids, decreasing it in another by obstruction of the pores with sulphate of ammonia, nitrate of potash, and so on, the wick is tempered to the varying substance with tolerably uniform success. The outward bending of the wick, so as to bring the tip into combustive contact with the air, formerly accomplished by saturation with pulverized metallic bismuth, according to Palmer's patent, is now achieved by simply tightening the plait on one side, thus setting up unequal tension.

In relation to the subject of guttering and smoking, it may be mentioned that a valuable patent exists, which is worked by Messrs. Field. Acting on the theory that smoking is produced by an insufficient supply of air, the candles are perforated throughout their length, the channels thus formed communicating with the outer atmosphere by means of lateral holes. The current of air impinging directly on the base of the flame consumes any excess of carbon, while the channels act as internal exits for the superfluous melted stearine. The most successful invention, however, for the prevention of guttering is the "lychnophylax," which being interpreted means "candle-god." This consists of an elegant little glass cap exactly fitting the candle, and sliding down as the substance is consumed. Being glass, it does not conduct the heat of the candle sufficiently to melt the wax on its own account, which is the case with all brass appliances for that purpose, and its construction is such that no amount of draught will cause the liquid grease to overflow the rim.

Wax differs from all other substances when used for making candles. It cannot be moulded because it adheres to the metal walls, hence it has to be poured upon the suspended wicks in successive increments. The shapeless cylinder is then rolled upon a hard marble slab, and shaped with a little piece of wood in the hands of men of twenty years' experience. The two "wax-men" at Messrs. Field's have been over forty years at this work. The sealing-wax man, named John Walters, aged eighty, is the oldest on the premises; when he was first engaged, sixty years ago, bees drew honey from the flowers where now the South-Western Railway runs, and Lambeth Marsh was a marsh in reality. Sealing-wax is so called because it contains no wax, and never did.

Among our engravings accompanying this article are two sectional representations of the steam apparatus of M. P. Morane, Sen., of Paris, for the manufacture of stearic acid under pressure.

GROUND slates of different colors may be used to give shades, deducting from the sand in proportion to slate used.

THE MICRO-PHOTOSCOPE.

THE micro-photoscope consists of a pair of spectacles, eye-glasses, or an eye-glass, with one or a number of micro-photographs arranged in or along the upper part of the rim or framework of the aforesaid spectacles, eye-glasses, or eye-glass, as represented by the annexed drawing.

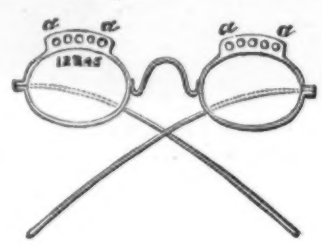
The micro-photographs in or along the rims are arranged behind, and attached to suitable microscopic lenses; *a a* are the parts of the rims which contain the micro-photographs 1, 2, 3, 4, 5; and the wearer of one of these instruments (the "micro-photoscope") will be able, by simply moving his eyes, to look through any one of the micro-photographs.

The micro-photoscope will be worn in the same manner as ordinary spectacles or eye-glasses.

The micro-photographs may be photographs of written or printed matter, maps, charts, views, landscapes, pictures, or any object or groups of objects from which a photograph can be taken.

Some of the uses to which the "micro-photoscope" could be applied are the following:

For a student: The series of micro-photographs in



the rims of the spectacles might consist of copies of an epitomized grammar, history, geography, or any subject the student wishes to study. Thus the subject he was studying would be constantly before his eyes for reference in his spare moments without the trouble of carrying books about with him.

A lecturer might have the heads of his lectures photographed, and placed in the rims of his spectacles; a lawyer, his briefs; a clergyman, his sermons; a bicyclist, tricyclist, or other tourist, maps, views, and plans of the country through which he traveled; a shopkeeper, a calendar, ready reckoner, and so forth; a timber merchant or builder, cubes, measurements, and rules; travelers on the Continent, list of foreign terms, names of articles, foreign money, tables, and so on; a correspondent, an abridged dictionary of technical or difficult words; a member of Parliament, facts and figures relating to the subject of his speech; a doctor, formulæ; a public entertainer, recitations, songs, bon-mots, etc.; a musician, whole pieces of music; a detective, criminals wanted.

This is the invention of R. G. Mason, schoolmaster, of Douglas, Isle of Man.

GABERT'S REVOLVING EXCAVATOR.

WE illustrate herewith, from *Le Genie Civil*, a type of excavator constructed by Messrs. Gabert Bros., for work on the Panama Canal.

The apparatus (shown in perspective in Fig. 1, and in detail in Figs. 2, 3, and 4) consists of a fixed truck of double T-irons resting upon two axles. At its upper part it carries a series of rollers, and rests at the center upon a pivot designed to support the movable part of the apparatus. The base is a circular turn-table which revolves over the rollers and carries the central frame at whose summit is situated the shaft of the upper bucket chain wheel.

The excavating machine, the boiler, and the windlass for raising the bucket frame are likewise mounted upon the pivoting part of the apparatus. As regards mechanism, the truck carries merely a small engine designed, on the one hand, to move the excavator, and, on the other, to revolve the turn-table. The motor is a single-cylinder vertical engine provided with reversing gear. Its effective power is that of 18 horses, with 60 revolutions per minute. Through the intermedium of a long connecting rod, it actuates a fly-wheel placed nearly at the summit of the frame. The transmission to the shaft of the upper bucket chain wheel is effected through the intermedium of a pinion and wheel, which, for each 60 revolutions of the engine, revolve the bucket-chain wheel 12 times, this representing 25 buckets per minute.

The bucket-chain consists of 21 elements, each of which includes one 22 gallon bucket and four female links and two male ones. The total stress that it supports while at work is 7,117 pounds. The upper chain wheel is square, and consequently without cams; the lower one is circular, and is 37 inches in diameter.

The bucket-frame is peculiarly arranged. Instead of being hinged at its upper part, it rests simply upon the shaft of the chain wheel; and for this reason the shaft is provided with cast iron sockets which do not participate in the rotary motion. A double spring is placed at the upper part of the bucket-frame, between two double T-iron cross pieces. One of these is movable, and is connected with the frame of the elevator by flat iron tie-bars. The other is fixed to the sides of the bucket-frame. These tie-bars hold the movable cross-piece against the springs, which, reacting upon the fixed cross-piece, thrust the bucket-frame downward and cause the buckets to bear against the base of the cutting. But if an obstacle comes in the way of a bucket, the bucket-frame rises under the stress, by compressing the springs, and the bucket escapes. As may be seen, this arrangement prevents breakages without the necessity of stopping the apparatus for that purpose when hard or too large objects present themselves. The bucket-frame is suspended toward its lower extremity by means of chains that pass over an inclined jib, whose base is hinged to the turn-table. This jib consists of two parallel beams that are connected above by a horizontal axle and support a large iron drum designed to keep the lower part of the chain away from the excavator. The chains which suspend the bucket-frame are wound up by a windlass set in motion by the fly-wheel shaft of the principal engine. A double conical gearing permits of rotating, in one direction or the other, a long rod that carries an endless screw at its lower extremity. This screw gears with a helicoidal wheel mounted upon the shaft of a pinion that actuates a spur-wheel keyed to the axle of the windlass drums. These latter are two in number, and correspond to two chains, each of which is attached to one of the sides of the bucket-frame after passing over the pulleys at the top of the jib.

This mechanism as a whole is slightly complicated, but it is easily maneuvered, the engineman, in order to lower or raise the bucket-frame, having only to act upon the conical gearing by means of a lever placed within his reach.

Among the peculiarities of the Gabert excavator, we may cite the arrangement of the chute. As this participates in the rotation of the entire apparatus, it must be so arranged that it shall be possible to direct it in such a way that it will always bring its extremity over the car to be loaded. To effect this result the chute is mounted upon a pivot, and its lower part is held by a roller which moves over a circular track fixed to the excavator frame. The desired direction is given from the ground by means of a chain attached to the chute.

In order to complete the enumeration of the apparatus mounted upon the turn-table, it remains for us to mention the boiler, which is placed between the cheeks of the bucket-frame. This generator, which has a heating surface of 215 square feet, is tubular and horizontal, with return flame. It is registered at 13 pounds.

Upon the truck there is arranged a small, from 5 to 6 H. P., vertical engine which has a double duty to perform, viz., to move the excavator backward and forward on its track, and to revolve the table that carries

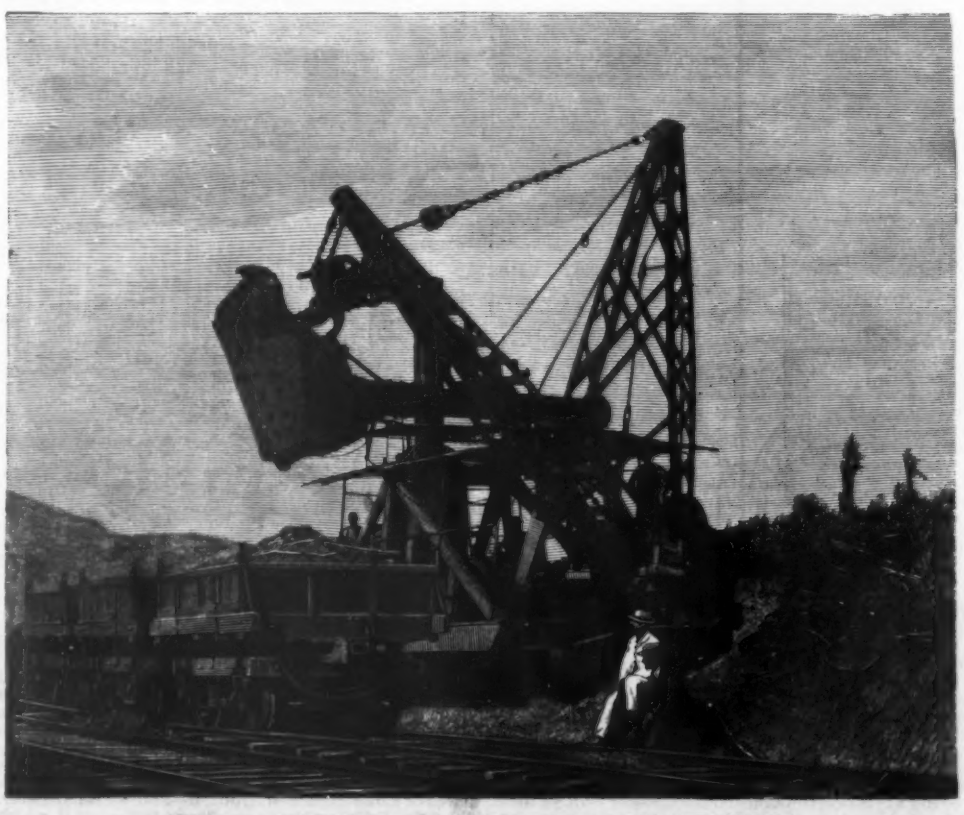


FIG. 1.—GABERT'S REVOLVING EXCAVATOR.

all the excavating apparatus. The backward and forward motion is obtained through the intermedium of an endless screw with a helicoidal wheel, of a spur gearing, and of a pitch-chain that actuates one of the axles of the excavator. Another pitch-chain establishes a connection with the other axle. To revolve the turn-table, the engine transmits its motion through bevel gearing to a vertical shaft that carries a pinion over which passes a cable whose two extremities are attached to either side of the movable table. The two motions under consideration are obtained through the intermedium of double coupling clutches that permit of acting in one direction or the other. The engineman of this machine must be an experienced person, for upon him depends the proper running of the entire apparatus. By means of two levers that he grasps, he approaches or recedes from the foot of the bank, and directs the bucket-frame to the desired position. In order to guide himself, he must especially examine the bucket-frame springs, the compression and expansion of which accurately show the situation of the buckets that are attacking the earth.

The Gabert excavator in working forward is capable of opening a trench about 30 feet in width. If it be desired to exceed that limit, the bucket-frame may be placed in a plane perpendicular to the track. But in this case the apparatus has no longer any stability, and in order to support it, it would be necessary to add to each side of the fixed frame auxiliary rollers that revolved over two rails external to the normal track. Under such circumstances the apparatus would simply perform the *role* of a surface excavator, and would have no *raison d'etre*, since there are simpler, more stable, and more easily maneuvered apparatus for that purpose already in existence. This observation applies to large works like those of the Panama Canal, and not to small enterprises, which may have the advantage of possessing but a single apparatus, and of utilizing that in every case that presents itself. The theoretic performance of the Gabert excavator is 25 buckets per minute, or 1,500 per hour, and 15,000 per day of 10 hours, which gives, at 22 gallons per bucket, 52,980 cubic feet. As for the practical performance, it ought to be, under favorable working conditions, about 35,200 cubic feet; but that depends essentially upon the surface of the ground, the skill of those who run the apparatus, and the organization of the tracks.

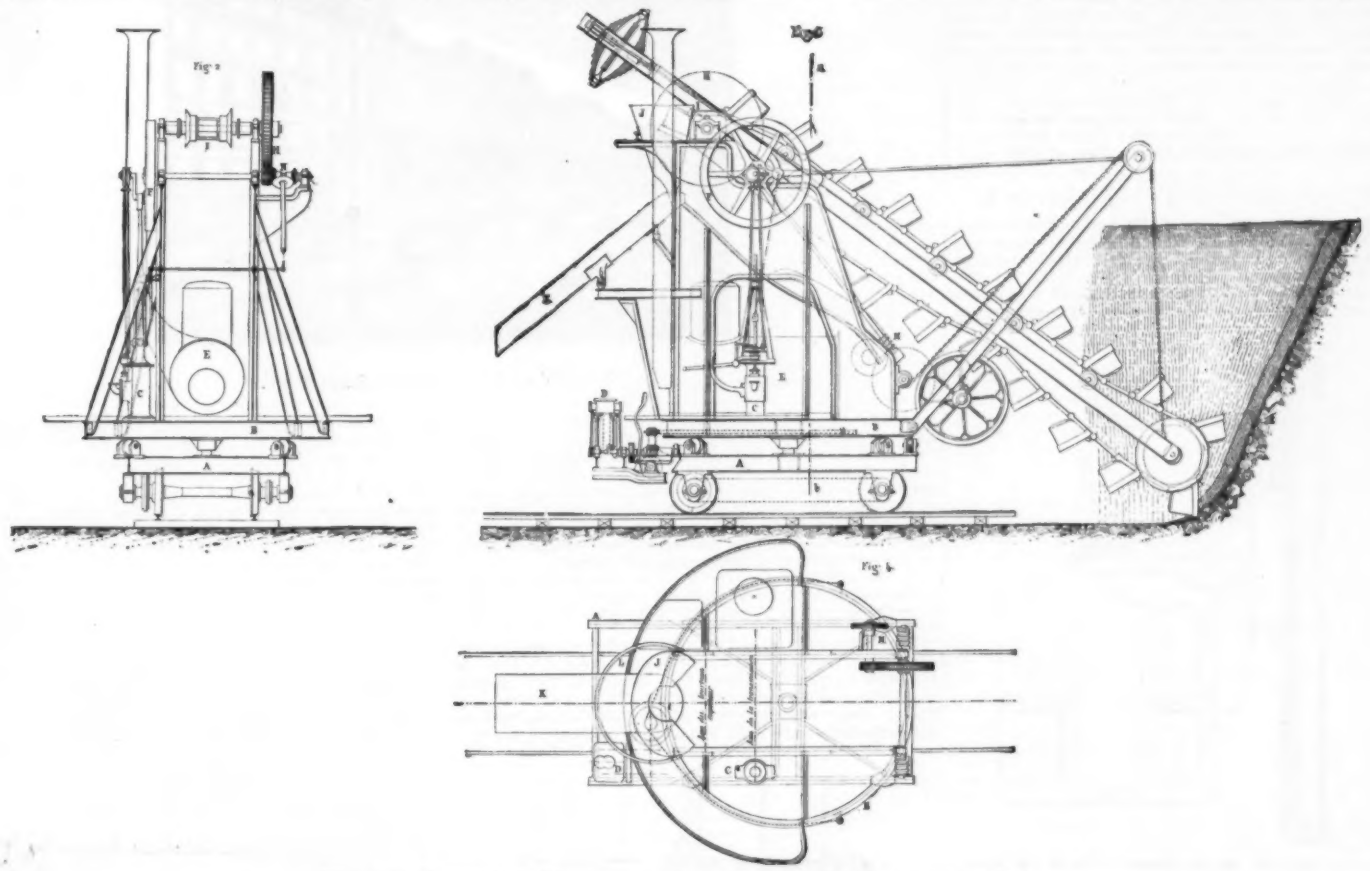


FIG. 2.—SECTION THROUGH *a b*. FIG. 3.—ELEVATION. FIG. 4.—PLAN.

GABERT'S REVOLVING EXCAVATOR.

Description of Figs. 2, 3, and 4.—A, truck; B, revolving frame; C, principal engine; D, small engine; E, boiler; F, fly-wheel; H, *h*, gearings that transmit motion to the upper chain-wheel; I, upper chain-wheel; J, hopper; K, movable chute; L, track for directing the chute; M, mechanism of the bucket-frame windlass; N, gearing that actuates the mechanism of the bucket-frame windlass.

RAILROAD BUILDING IN THE TROPICS: PONTOON BRIDGE ACROSS LAKE AMATITLAN ON THE LINE OF THE GUATEMALA CENTRAL RAILWAY.

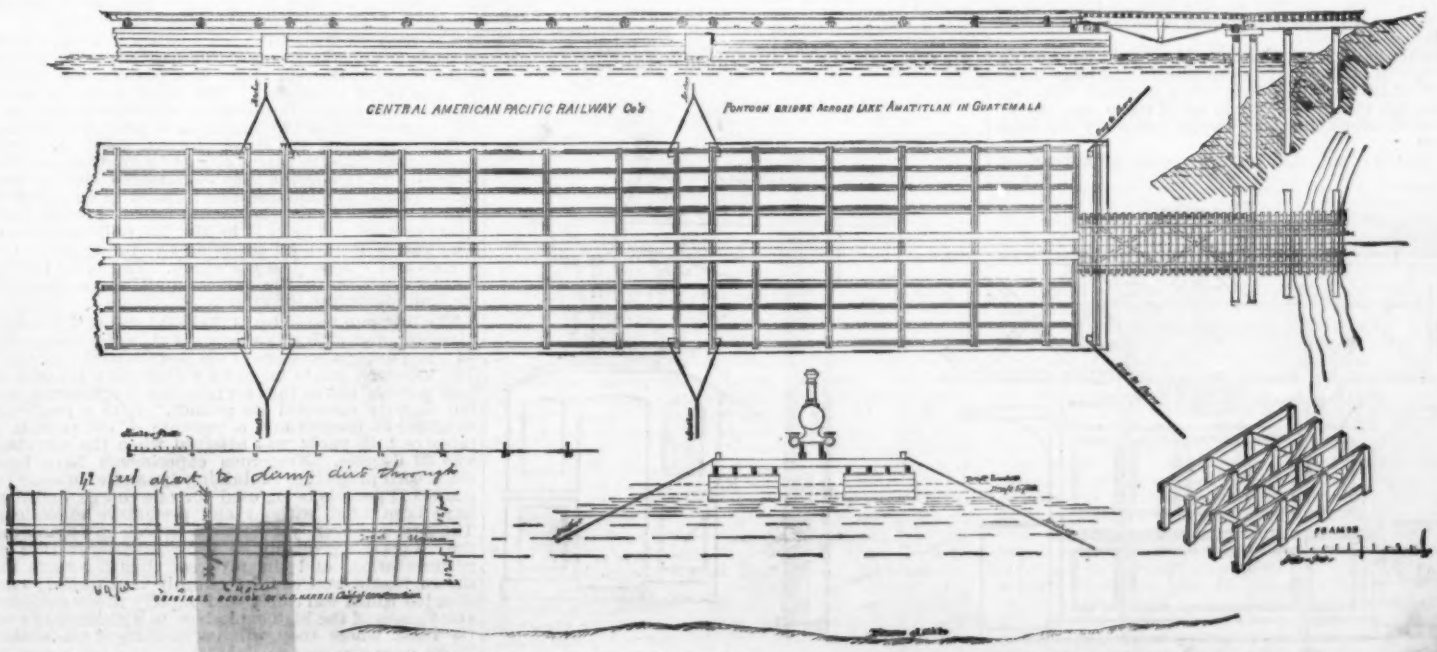
THE pontoons in this structure were 17 feet 9 inches wide, 64 feet 3 inches long, and 3 feet 4 inches deep. These were placed in two lines across the opening of 700 feet. A separation of 10 feet was left between the lines of pontoons, so that the embankment could be raised to grade before removing them. The ends were separated 5 feet, and sixteen pieces of Oregon pine, 3 by 12 inches, laid on the decks of the pontoons, made the longitudinal connections; these were crossed on each pontoon by twelve pieces 7 by 16 inches, on the top of which the track stringers, 12 by 12 inches, were laid.

The shore ends were connected with the land by substantial aprons, and the structure was kept in line by anchors in the lake, which has a mean depth of 50 feet to a very soft deposit of 10 feet, through which to tough clay makes whole height of embankment 65 feet.

This lake is about twenty-five miles in circumference, and is bounded by basaltic cliffs and very uneven country, except at this point, where Lobos River (a rapid stream from the foot of Volcan Agua) has sent its washings out into the lake and deposited a level tongue of land across to within 700 feet of the western shore, in which gap the pontoons have been holding up the traffic service of the country, besides facilitating the work on embankment. The engines passing over the bridge weigh 45 tons, and trains average 195 tons, making in all 240 tons, and this has been continued for three months without accident or injury to rolling stock.

The plan accompanying this is an exact representation of the pontoon bridge, which was conceived by and constructed under the immediate supervision of Mr. J. B. Harris, and adds new laurels to his railroad fame.

The contracts with the government of Guatemala made it necessary to have this road in operation long before the embankment across Lake Amatitlan could be finished or a line constructed around it; hence the necessity for a temporary bridge.


CENTRAL AMERICAN PACIFIC RAILWAY Co's
PONTOON BRIDGE ACROSS LAKE AMATITLAN IN GUATEMALA
½ feet apart to dump dirt through
FRAMES

PONTOON RAILWAY BRIDGE, LAKE AMATITLAN, GUATEMALA.

Mr. Harris' arrival on the ground brought new life to the lagging work; and infusion of his own energy in those who were already in the field, together with his skill and perseverance, has finished the road.

The pontoons have done their work, and their planks are spiked down for platforms at stations. A facsimile of the original drawing of pontoons, which Mr. Harris made on a blotting pad, is part of the accompanying plan.

The quantity contained in the embankment it was impossible to estimate exactly, as several unaccountable sinkings occurred during the progress of the work, but one-half million yards of material would scarcely fill the borrow pits.

Lake Amatitlan evidently fills the place of an ancient crater, compared to which the three, Pecaya, Fuega, and Agua, are mere pygmies. These are within a radius of twenty miles from the lake, and the old city of Guatemala was destroyed during an eruption of Agua in 1783.

CHAS. BULKLEY,
First Assistant Engineer,
Guatemala Central Railway.
Guatemala City, Central America, Dec. 4, 1883.

A PROJECT FOR A SUSPENDED RAILWAY.

MR. ANGELY, an engineer of arts and manufactures, proposes, as a solution of the question of passenger transit for cities, a suspended railway, which we shall briefly describe.

It consists of two girders supported at 25 feet above ground by a single row of columns. These girders,

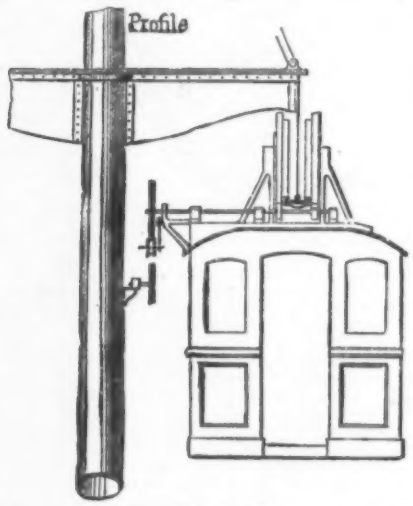


FIG. 1.

one of which is designed for the up track and the other for the down, carry two rails for supporting the cars, the wheels of which are placed in pairs on each side of the web of the girder.

The columns, which are spaced about 105 feet apart, have a mean height of about 40 feet and are made of ¼ inch iron plate. They are firmly affixed to a beton foundation by bolts, and are surrounded at their base by a foot pavement that may serve as a place of refuge. The two girders are supported at three points in the interval between the columns by tension rods fixed to the summit of the columns. In addition to this, they are connected with each other by transverse and oblique braces that render them interdependent, and that give the structure all the rigidity desirable.

Mr. Angely thinks that three arrangements might be employed for traction: (1) by telodynamic cable; (2) by locomotive; (3) by electric motor.

(1.) *Traction by Cable.*—For this mode of traction the power would be transmitted by a telodynamic cable instead of a traction cable properly so called. This would do duty for the two tracks, up and down, and be given a velocity of 114 feet per minute. Practice has demonstrated that great velocities like this are necessary in order to secure to this kind of transmission of power to a distance a proper working and a long duration of the cable.

A cable moving at this velocity would be capable, although of small section, of transporting a large quantity (90 or 100 H. P.) of energy to a distance, thus permitting ten trains, each made up of three cars, to obtain, at the same time, the energy necessary for their motion.

By reason of the slight stress required for traction, and of the great velocity of the cable, the author of the project transmits power to the driving wheels by a very simple arrangement.

As the cable has a velocity of 114 feet per minute, the power requires but a feeble tangential stress upon the rim of the pulley, say about from twenty-six to thirty-three pounds. For this reason the cable need not run round the pulley, but sufficient adhesion may be had by pressing it into the channel of the receiving pulley (Fig. 1) through a roller mounted at the extremity of a lever.

(2.) *Traction by Locomotive.*—Traction by locomotive would be effected by light engines of 12 H. P., but for metropolitan service we would not recommend them, on account of the following inconveniences: Fall of cinders upon the roadway beneath, the difficulty of getting fuel to them, noise of the escape steam, and smoke. It is true that in the most recent engines built for tramway service, these inconveniences have been partially overcome, but yet no success has been obtained in the endeavor to entirely suppress them.

(3.) *Traction by Electric Motor.*—The results already obtained with electricity permit electric motors to compete in such an application as this, since they are light and are very easily moved.

The electricity would be furnished by a stationary motor and transmitted to a dynamo motor on the car through a special cable. The return of the current would be effected through the metallic framework, thus doing away with the use of the rails as conductors, since the latter are held upon their bases by bolts that

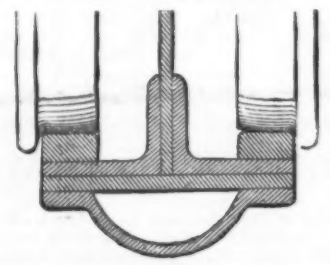


FIG. 3.—TRANSVERSE SECTION OF THE LOWER PART OF THE GIRDER AND TRACKS (Scale ½).

would themselves have to be insulated; and, as this is very difficult to do in practice, it justifies the use of a special cable for leading the current.

The dynamo motor designed for giving motion to the wheels would be of the Gramme or some other type, and would be placed upon the floor of the car.

The stations would be established in houses at the sides of the street, and would communicate with the cars through a light foot-bridge. The road would thus be free from the incumbrance of offices for the sale of tickets, etc.

It is well to point out that, aside from its application to city service, Mr. Angely's arrangement might be applied in various cases where the question of carriage finds a difficult solution with our present means. In mountainous countries, especially, it might serve for supplying cities or localities distant from railways with

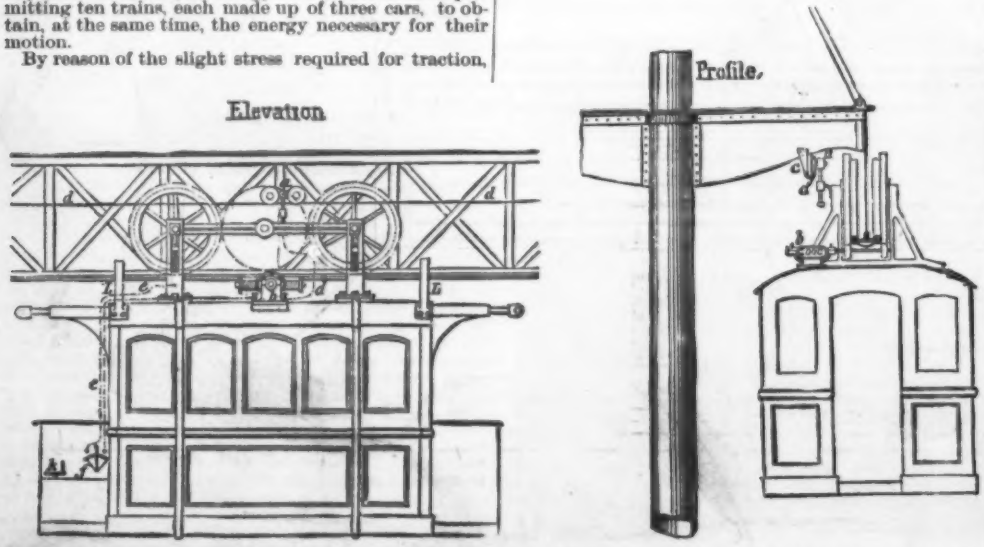


FIG. 2.—ELEVATION AND PROFILE OF A CAR ACTUATED BY ELECTRICITY (Scale ⅛).

water, and this too without those constructive works that occasion an expense that is often little in keeping with the service rendered. The bearing points, 90 or 130 feet apart, might be easily located along drift-ways, or even upon the mountain side.—*Le Genie Civil.*

SOME RECENT EXPERIMENTS ON THE USE OF HIGH EXPLOSIVES FOR WAR PURPOSES.

By Prof. CHAS. E. MUNROE, U.S.N.A.

SINCE the processes have been perfected by which nitroglycerine and gun-cotton have been rendered comparatively safe during handling and storage, active efforts have been made to devise means for employing them as offensive and defensive agents. Heretofore these efforts have been confined to the use of these explosives in torpedoes and submarine mines, but while these have proved in some measure efficient, yet they have been found to be costly and difficult of application, especially when the enemy was in motion, while the apparatus could be used but once, since it was destroyed by its own explosion. Hence, attention is now directed toward the invention of methods which will combine accuracy and readiness of application to a desired point while admitting of rapid and repeated use. As gun-powder has been successfully used in shells, this method of projecting the high explosives has naturally suggested itself; but as these bodies have been found to be liable to undergo an explosive reaction if, when confined, they are exposed to a violent shock or to the influence of an explosive wave, and as the pressure exerted by the powder-gas, in the chamber of a gun, becomes very great before the projectile is moved from its seat, it has been generally feared that a shell charged with a high explosive would be exploded before it left the gun.

ANGELY'S SUSPENDED RAILWAY.

For this reason other means for propelling the projectile have been sought, and as it has been shown by the Perkins steam gun and the common air gun that the expansive force of high pressure steam or of compressed gases possesses for this purpose a considerable degree of efficiency, while at the same time the pressure can be so regulated that the projectile can be started without being subjected to any considerable initial shock, this form of gun has been recently adopted for experimental purposes. The velocity is attained by lengthening the gun so that the projectile is exposed for some time to the action of the expanding gases.

The air gun recently under trial at Fort Lafayette, New York Harbor, is represented. It consists of a seamless brass tube forty feet long and one-quarter inch in thickness, mounted upon a light steel girder. This is trunnioned and pivoted on to a cast iron base, thus enabling it to be swung in any desired position. To assist in this operation guys are placed on either side of the base, and their length can be changed by turning the hand wheels. Compressed air is introduced to the gun from below, and passes up through the center of the base to a pipe connecting with one of the trunnions, which is hollow. The air is thence introduced into the pipe on the side of the gun which leads to the valve. This valve is a continuation of the breech of the gun, with which it is connected by a pipe leading upward. The valve is automatic in its action, and so regulates the supply of air that the pressure increases until the projectile leaves the gun, when the valve closes.

The peculiar projectile used consists of a thin brass tube in which the dynamite charge is placed; an air-space is left at the rear to act as a cushion, and then a wooden sabot is inserted. This sabot flares out until its diameter equals the internal diameter of the gun. The forward end of the brass tube is pointed with some soft material, and the firing pin with its detonator is embedded in this, so that it cannot be fired except upon impact. The projectile is so constructed that its center of gravity is some distance forward of its center of figure. Hence a side wind would tend to turn its head into the wind and keep it in the line of its trajectory. The gun is loaded by inserting the projectile in the breech and closing the gas check. The lever is then moved which opens the valve, admits the compressed air, and discharges the gun.

The first gun tested by Lt. Zalinski was two inches in diameter, and with this a range of 1¼ miles was attained when using a pressure of 420 pounds to the sq. inch. The four-inch gun is made to withstand a pressure of 2,000 pounds, but as thus far reported the pressure used but slightly exceeded 500 pounds. With a projectile weighing 24 pounds and a pressure of 500 pounds, a range of 2,100 yards was attained when the elevation was 22 degrees. Numerous experiments have been made with projectiles containing dynamite, in some instances 15 pounds being used for one charge, and they have been fired without any premature explosions. The gun, however, yet appears to lack in accuracy of fire. This can probably be corrected after further experimentation, and the progress thus far made has shown that a gun can be cheaply and quickly constructed which will safely and rapidly throw considerable masses of the high explosives to a distance of over 1¼ miles, where they will be discharged on impact. These guns are also so light that they can easily be used on small launches, and the absence of all report

and of a flash of light during the discharge commends them for night attacks. It is proposed now to construct an eight-inch gun to carry from 100 to 125 pounds of explosive gelatine.

In determining the efficiency of these projectiles against an armor clad vessel, we may assume that one of four effects may be produced, depending on the resistance of the armor to penetration and on the material, thickness of wall, profile, weight, and velocity of the projectile.

(1.) The projectile may either penetrate the armor partially and explode in place, or pierce it completely and burst inside of the ship. This is the condition of greatest efficiency.

(2.) It may explode immediately upon impact and before breaking up. Then the explosive will exert the energy which it develops through explosion in a resisting receptacle.

(3.) It may rebound before exploding. Then the effect will be reduced by the interposed cushion of air.

(4.) It may break up on impact before the explosion takes place. Then the energy of the explosive will be simply that which it develops when exploded unconfined.

The resistance of an armor to penetration depends upon its hardness, its tensile strength (that due to bolting as well as that inherent in the metal itself), and its inertia. The latter is augmented by the thickness and weight of the armor and by the rigid system of bracing which now obtains in practice. How great this resistance is can best be illustrated by an example. While, from the fact that very rapid progress is being made in the improvement of armor plates, we may not have chosen the best example, let us take the steel plates designed for the Furieux. One of these, weighing 23 tons 9 cwt, and averaging over 17 inches in thickness, was tested at Gâvre, July 13, 1883. Three shots were fired against this plate from a 12·6 inch rifle using chilled iron projectiles weighing 759 pounds each. The first and second shots struck with a velocity of 1,403 feet each. The third struck with a velocity of 1,438 feet. The projectiles were all broken up, all of the twenty bolts through the plate remained intact, and no portion of the plate fell from the backing, although it was somewhat indented and cracked.

Although we are not yet informed concerning the air gun projectile, except for the weight given above and the pressure of the air also cited, yet when we remember that in the Gâvre experiments the pressure of the powder gas probably approached 40,000 lb. to the square inch, it is not unfair to infer that with a pressure of 500 lb. to the square inch a projectile will possess little or no penetrative power against the Furieux plates at a distance of 1¼ miles. Whether then the projectile would explode on impact or after rebounding, or whether it would break up before exploding, is a matter for speculation and conjecture. If the last condition prevails, then we can judge from some experiments recently made by Lieut.-Commander Folger, at the Naval Experimental Battery, under the direction of the Naval Bureau of Ordnance, what the destructive effect would probably be.

The target used in these experiments consisted of eleven slightly convex iron plates, each one inch in thickness, which had been perforated with bolt holes. They were such plates as were used during the war for covering the turrets of the original monitors, and the bolt holes were made before the delivery of the plates. The plates were fastened to the twenty-inch thick oak backing by fourteen tapering 1¼ inch iron bolts, which were flush on the surface of the target and passed entirely through the backing. These bolts are indicated in the figures by numbers. Before this target was constructed, 265 pounds of dynamite in ten successive charges, varying from five to seventy-five pounds, were exploded against plates fastened to this same structure without materially damaging it.

The No. 1 kieselguhr dynamite used was made at Newport, and was in excellent condition. The charge was placed in a woolen cartridge bag, a netting lashed about it, and then the whole suspended from the wooden cross-piece which projected from above the target. The cord suspending the charge was carried over and behind the top of the plates so as to bring the charge in contact with the face of the plates, and, as an additional precaution, the charge was jammed close against the target by pressing on it. A hole, about three inches deep, was made in the side of the charge farthest from the target, and two detonators, arranged in series, and containing together 85 grains of mercuric fulminate, were embedded in it.

In the first experiment 100 pounds of dynamite were exploded as described. The result was the indentation of the plate to the depth of two inches at the center, and extending over a circular area of about two feet in diameter. The outer plate was sprung from the bolts, at each end. The outer pair of plates separated about a quarter of an inch. In general, however, a good contact remained for all the plates. The backing and bracing were practically uninjured. An old crack in the middle upright, due to checking, had widened slightly. The whole structure had sprung back two inches, but had recovered itself in the marshy ground in which it was embedded.

In the next experiment a one-inch iron plate was placed horizontally in contact with the target, and a charge of 75 pounds of dynamite was forced tightly into the angle between the plates and exploded. The result was that the indentation in the target was increased by about one inch, but all the plates and bolts remained unbroken. The ends of the plates curved outward, the outer one about one inch. The structure was somewhat racked and strained, but still remained quite solid. It had as before sprung back about two inches. A portion of the backing on the left, which had been much weakened by bolts passed through it, was broken off and partially displaced. The effects on the backing were somewhat more pronounced than in the previous round, but this was probably as much due to the repeated blows of 440 pounds of dynamite as to the particular position of the charge in the last experiment. The platform of blocks and the iron plate, which in the experiment represented the water surface in contact with the armor, was demolished, the plate being badly torn and the wood pulverized. Mr. Folger concludes from these experiments, that "it is a matter which hardly admits of doubt, that a modern armorclad will not be materially injured by the explosion, in superficial contact with her overwater plating, of charges of more than 100 pounds of dynamite." We would add to this that in the case of the breaking up of a projectile before exploding, the explosive material may be scattered over a considerable area, and thus diminish the effect produced at any given point.

On turning again to the description of the air gun projectile, it will be observed that, as with nearly all of the shells in use which are to be exploded by impact, the detonator is placed in front of the explosive. As we are accustomed to regard the explosion of our high explosives, when induced by detonation, as instantaneous throughout the mass, it has seemed a matter of no importance, as regards its effect on the explosive, where the detonator was put. Berthelot has, however, advanced the theory that while the reaction started by the first shock in a given explosive material is propagated with a rapidity which depends upon the intensity of the shock, and while this intensity may vary considerably according to the method by which it is produced, yet the pressures which arise from the shock exerted on the surface of the explosive are too rapid to become uniformly dispersed throughout the entire mass, and the transformation takes place locally among the layers first reached. If it is sufficiently violent, they may then be heated to the necessary temperature, and they will be immediately decomposed, and produce a large quantity of gas. This production of gas is in its turn so violent that the shocking body has no time to displace itself, and the sudden expansion of the gases of explosion produces a new shock, probably more violent than the first, on the layer situated below. The mechanical energy of this shock is changed into heat, in the layers which it reaches, and produces an explosion; and this alternation between a shock developing mechanical energy which changes into heat and a production of heat which elevates the temperature of the layers up to the degree necessary for a new explosion capable of reproducing the shock propagates the reaction, molecule by molecule, through the entire mass. The propagation of the explosion takes place in this way in consequence of phenomena comparable to those which produce a sonorous wave.

In view of this theory, experiments were made at the Naval Experimental Battery. Two charges of dynamite of ten pounds each were inclosed in woolen bags, suspended as in the previous experiments, and exploded successively before the one-inch iron plate shown in Fig. 6. The two experiments differed only in the fact that while in the first the exploder was inserted in the side of the charge farthest from the face of the plate, in the second case the explosion was inserted in the side of the charge in contact with the plate. The result of the first explosion is shown on the left hand of the figure. The area of the hole was about 192 square inches, and the edges were quite cleanly cut. The result of the second explosion is shown on the right hand. The area of the hole was about 96 square inches, and the sides were pushed outward as if subjected to a slow and somewhat continued pressure.

In connection with his tests of the dynamite air gun, Lt. Zalinski has also tried exploding dynamite in contact with iron plates. The two experiments reported are as follows: Fifteen seven-eighths inch iron plates were piled one upon another. Upon these an iron canister, containing twenty pounds of untamped dynamite in four paper cartridges, was placed. About this the remains of four large iron boilers were placed as shields, and then the dynamite was exploded. The result was that plate No. 1 was shattered, plates Nos. 2 and 3 were crushed, plate 4 fell to pieces when lifted, while 5, 6, and 7 all showed the effects of the blast. The iron boilers were blown to a distance of several yards, while the ground was torn up to some distance.

In the second experiment a pile of fifteen five-eighths inch plate was used, and seventy pounds of tamped dynamite, inclosed in a cylinder, was placed upon it. The boilers were placed about the pile, and the charge exploded. A large hole was blown through twelve of the plates, and the boilers were blown to a distance of thirty yards, and riddled.

A somewhat similar experiment in which gun-cotton was substituted for dynamite was made by Lieut-Commander Folger. The target represented in strength the protective deck of a modern armored vessel. Three one-inch iron plates were firmly joined together by eight one-inch bolts. Heavy timbers, serving as a support, were placed upon the ground at a distance of 4½ feet from one another, and the plate was laid horizontally upon them, and fastened to them by two one-inch bolts at each end, which passed nearly through the timbers. The plates were of the same lot as those used in the other targets at the Experimental Battery, and in order to counteract as far as might be the weakening effect of the bolt holes, plates of iron one-fourth inch in thickness were inserted on either side of the middle plate, and a third one was placed above the top plate. There was thus added a strength of three-fourths inch of iron.

After a number of preliminary trials to determine the best means for producing a perfect detonation had been made, a charge of 25 pounds of wet gun-cotton tied in a bag, with 20 ounces of dry gun-cotton and 80 grains of mercuric fulminate as an exploder, were placed on the target. A hole, 56 square inches in area, was blown through all the plates, and a hole, 18 inches deep, was blown in the rather friable earth beneath. The bending of the plates extended from the timbers, without starting the bolts, and reached a depth of indent of 7¼ inches at the hole. *The area of the base of the charge before explosion was about double that of the hole made.* The wet gun-cotton used was compressed in the form of disks, and it is a most curious fact that the area of the base of the charge beyond the limit of the hole was indented by the disks of gun-cotton in contact with the plate before these disks exploded. As the exploder was placed in the top of the charge, this observation seems to corroborate the results obtained when testing Berthelot's theory as to the transmission of the explosive reaction.

It will be observed that in each of the last described experiments the plates were far from being rigidly supported, and hence offered less resistance to a rupturing blow than they would have done if well braced. But as the target was arranged in the last experiment it fairly represented the somewhat flexible deck of an armored ship, and showed the degree of vulnerability of the weakest point, and what might result if we could reach that point with our explosive projectile.

At the beginning of this article we have said that it had been feared that the high explosives could not be fired in a shell with gunpowder as a motor without danger of a premature explosion in the bore of the gun. Abel, however, has long held other views, and some years ago he publicly expressed the belief that gun-cotton could be fired thus without danger, but that no one had the courage to try it. The experiment has now been successfully made, with several of the high explosives, and even so long ago as 1874 dynamite was so used under the direction of the Naval Bureau of Ordnance, the experiments on the high explosives made at the Experimental Battery, as reported here, being merely a continuation of these earlier experiments. More recently an experiment is reported as having been made in April last, at Greenville, N. Y., by F. H. Snyder. He fired dynamite by the aid of a slowly accelerating powder and a peculiar buffer devised by him. The cannon used was a brass field piece of about 4½ inches bore. A charge of a pound and a half of powder was put in, and this was followed by a sabot formed from alternate layers of iron, leather, copper, and paper, and made to fit the bore nicely. Next to this was a brass ring holding a rubber plug which was perforated with chambers at one end. Next came a long cylinder weighing thirteen pounds, and containing five pounds of dynamite in the end. The object in using the perforated rubber plug was to take advantage of the compression of the air confined in the cavities for gradually transmitting the force of the explosion to the dynamite projectile. The wooden sabot of the dynamite projectile was winged, so as to increase its accuracy of flight. In the experiments the dynamite was fired without any premature explosions, but no great range or efficiency seems to have been attained.

Another experiment is reported from Sandy Hook in July last. Here 5½ pounds of explosive gelatine were fired in an 8 inch dynamite shell. The gelatine was inclosed in a thick pasteboard cylinder, which was divided into four sections by two intersecting partitions. There was a cushion of cork in the shell, and a hollow rubber cylinder was placed between the charge and the shell. The paper case and the inside of the shell were well covered with graphite. There was no detonator in the shell, and it was probably intended to explode the gelatine by its own impact. The account of the experiments is meager, but it is said that service charges of powder (35 lb.) were used for firing the shells. Two rounds were fired. In the first, the shot went successfully to the target, and the point indented the iron about seven inches and exploded, but did no harm. The next shell got as far as the muzzle of the gun and burst in the bore, but doing no other injury, apparently, than scoring the rifling. These statements are made as reported, but it is quite probable that the shell broke up in both cases without any explosion of the gelatine.

Experiments in this direction have also been made at the Naval Experimental Battery. Some time since the trials were made with dynamite. In this instance, after a few preliminary experiments had been made (in which twelve rounds were fired, using considerable air space, reduced charges, and a small quantity of oakum in the bottom of the shell to serve as a cushion), ten charges of dynamite of 5½ ounces each were fired in 12-pounder spherical shells under service conditions, that is, with a full charge of powder and no air space. There was no premature explosion with any of the twenty-two charges fired, though one shell exploded on impact with the water. Five of the shells carried ordinary time fuses, and these exploded at the point and time intended.

Finally, on August 4, experiments were made at the same place in firing gun-cotton. After five preliminary rounds, ten rounds were fired, at a range of about 2,000 yards, with the 80-pounder (6·4 inch) B.L.R., using full service charges (10 pounds) of powder, and shells filled with wet gun-cotton (3 pounds). The only precaution taken to relieve the shock at starting was in placing a layer of oakum ¼ inch thick in the bottom of the shells. The shells were plugged with wood, as it was dangerous to explode them down the bay, on account of the great energy imparted to the fragments when high explosives are used in bursting charges, and as it has been demonstrated in previous experiments that it was feasible to explode gun-cotton shells at a desired range. Three rounds were fired, without fuses, at the target. The gun was fifty yards off, and the velocity of impact was about 1,250 f.s. The shells exploded on impact, as was shown by the small size of the fragments, by the fan-like spread of the scoring on the interior of the shelter erected about the target, and by the sound of the explosion which was heard. The effect on the target in each case was an indentation about 2 inches deep, with a diameter of 10 inches. No plates were injured. There was no case of premature explosion of the projectile in any of these experiments. It thus appears perfectly practicable to fire with safety, and under service conditions, charges of wet gun-cotton from a bore of considerable size.—*Van Nostrand's Magazine.*

NEW PHYSICAL PAPERS BY SIR WILLIAM THOMSON.

SIR WILLIAM THOMSON has just communicated three papers on important physical subjects to the Royal Society of Edinburgh. In one of them, dealing with the distribution of energy between colliding groups of molecules, the distinguished physicist called in question the explanation given by Boltzmann to a theorem first published by Professor John Clerk Maxwell, twenty-four years ago. Maxwell's first theorem, he said, was made the foundation of his kinetic theory of gases, whereas Boltzmann's explanation of it would have overthrown the kinetic theory; but the demonstrations of Boltzmann's theorem were not satisfactory, and the theorem itself did not seem probable, and could not be accepted without very stringent demonstrations. They might wait to doubt it, or see it disproved; he wished to call the attention of mathematicians to it, in order that they might find out whether it was true or false. Subsequently, dealing with the dynamics of reflection and refraction in the wave theory of light, Sir William Thomson gave the mathematical formulæ of a complete theory of refraction and reflection of light supposed to consist of vibrations in homogeneous elastic mediums of different densities and rigidities, as, for example, in air and glass, or air and water. He showed that the complete theory confirmed the views of Stokes, Lorenz, and Lord Rayleigh, to the effect that the density of the luminiferous ether was different in different transparent substances, while its effective rigidity was equal. The third communication dealt with Kerr's discovery regarding the reflection of

light from a magnet. That discovery, which had been made by Dr. John Kerr, of the Free Church Normal School, Glasgow, was a great advance on the investigation of Faraday's greatest discovery in electro-magnetism, which was the effect of magnetism on polarized light. Kerr had extended that discovery from the passage of light through transparent bodies to the reflection of light from polished surfaces or magnets. Commenting on the different character of the experiment, Sir William stated that Kundt verified Kerr's result, and then added to it a new discovery of the rotation of the plane of polarization of light through a translucent iron film. He found that an iron film $\frac{1}{1500000}$ part of an inch thick was translucent, and succeeded in getting such films, and made this optical discovery with them.

CALORIMETRIC VOLTAMETERS AND AMPEREMETERS.

IN a series of recently published articles, I made known different calorimetric methods which were applicable to electric researches, and which were based upon the invariability of temperature of the calorimeter. For this purpose it is necessary to have at one's disposal a compensative source of cold. With small apparatus the thing is relatively easy, but when we have to perform calorimetry upon large animals or upon man it becomes necessary to simplify the apparatus as much as possible. It was for the purpose of attaining this end that, toward the end of last year, I tried another method, one that is of simple installation, and of sufficient accuracy for this sort of research. It is a variant of the calorimetric method by radiation, to which I have added several improvements that render the use of it practical. The apparatus designed for human calorimetry is constructed as follows: The calorimeter, properly so called, consists of two concentric, cylindrical metallic vessels, one of them (1, Fig. 1) annular, hermetically closed, and communicating by the tube, 3, with a pressure gauge, 4, the use of which will be presently seen. This cavity is full of air. The second cavity, 2, constitutes the interior of the calorimeter, in which is placed the source of heat (a man, in Fig. 1). The calorimeter is suspended from the ceiling by a pulley, 6, and balanced by a weight, 7. Its base rests upon a pedestal, 8, provided with a circular channel full of water, making a hydraulic joint. In order to enter the instrument, it is lifted above the floor and then allowed to fall back into the channel. This maneuver presents no difficulty, owing to the suspension of the instrument. Beneath the pedestal there debouches a pipe, 9, of from 2½ to 3 inches in diameter, which passes through the partition. Ventilation is effected through the draught of the chimney, 9, in which a gas jet is burning. The external air enters the top of the calorimeter at 10, and, as ventilation is effected from top to bottom, the temperature is very uniform in the interior of the apparatus.

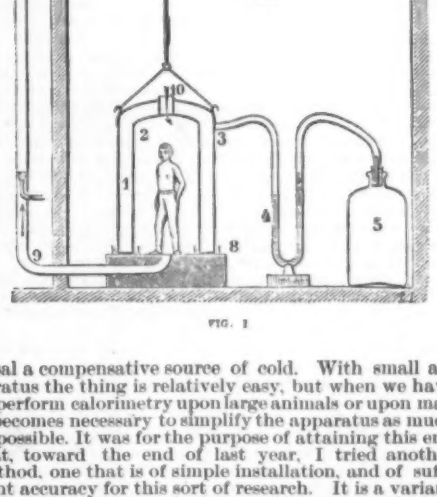


FIG. 1

Let us now suppose the apparatus connected with a simple pressure-gauge through the tube, 3. Then, if a source of heat is placed at 2, it will heat the air of 1, and the temperature will rise until the loss through radiation is equal to the production. This increase of temperature is shown externally by the motion of the pressure-gauge column, which gives a measurement of it.

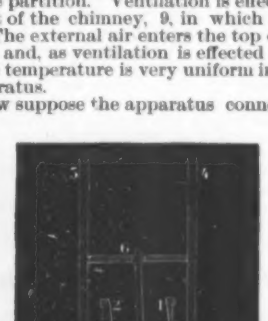


FIG. 2.

This calorimeter is nothing else, as may be seen, than a large hollow air-thermometer in whose cavity is inclosed the source of heat. In this arrangement is easily recognized the principle of my direct regulators, and the advantages of it, as regards the accurate measurement of temperature, will be seen without my pointing them out.

According to Newton's law, the quantity of heat radiated (that is to say, produced) in a given time is proportional to the excess of temperature of the calorimeter over the surrounding medium, for differences less than 30°. Should we employ an open-leg pressure gauge, for measuring the heating of the cavity 1, it would be necessary to take into account the barometric and thermometric variations of the surrounding medium while the experiment lasted. In order to eliminate these two connections at one and the same time, I connect the second leg of the gauge with a large jar, 5, in the same room with the colorimeter. With this arrangement the gauge constantly indicates the difference between the temperature of the calorimeter and the surrounding medium, that is to say, precisely the quantity to be measured.

The apparatus as a whole, then, is a differential air thermometer analogous (aside from dimensions) to the Leslie apparatus, and just as sensitive as that.

At present it is necessary to graduate the instrument experimentally in order to make a measuring apparatus of it. Such graduation is one of the simplest of matters. I place in the apparatus a constant source of heat whose intensity is known beforehand, and I observe the indication of the corresponding gauge. We may take as a heat source a jet of pure hydrogen whose heat of combustion is known, or a platinum spiral heated by a current, or a simple jet of steam of 100°. I shall not dwell upon the details of this operation, as I have only need here to give the principle of it.

The graduation once finished, a simple reading of the gauge will, at each instant, give the heat produced by the animal under experiment.

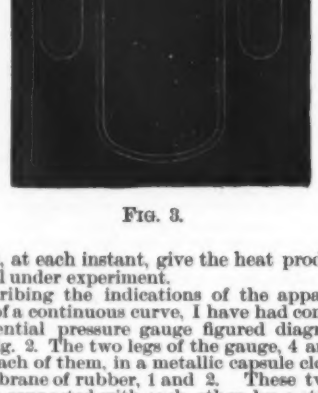


FIG. 3.

For inscribing the indications of the apparatus in the form of a continuous curve, I have had constructed the differential pressure gauge figured diagrammatically in Fig. 2. The two legs of the gauge, 4 and 5, terminate, each of them, in a metallic capsule closed by a thin membrane of rubber, 1 and 2. These two membranes are connected with each other by a stiff crosspiece, 3, that actuates a lever, 6, whose point traces a curve at 7 upon the registering cylinder.

As the membranes 1 and 2 have exactly the same surface, no movement is produced if equal pressures are exerted at 4 and 5. The apparatus is only influenced, then, by the *differences* of the pressures to be measured.

The indications of this calorimeter are very rapid, on account of its feeble calorific capacity; and, like my direct thermo-regulators, it exhibits no *lost time* in its operation. By reducing the proportions of this apparatus I have been able to make a toy calorimeter of it, constructed entirely of glass, and nevertheless presenting great sensitiveness. It is shown in Fig. 3. It consists of two calorimeters, 1 and 2, of blown glass, which form the two bulbs of a Leslie differential thermometer. A cock, 3, serves to unite the masses of air at will. The operating can be done in either calorimeter, and the instrument is thus more symmetrical. It can, moreover, be given any other form that may be fitted for the use to be made of it.

Upon observing the simplicity and precision of this little apparatus, the idea naturally struck me to use it for measuring the heat disengaged by an electric current. For this purpose I had only to place in the calorimeter a platinum spiral which traversed a cork, in order to convert the apparatus into an amperemeter or voltameter at will, according to the size, or, in other words, the resistance of the spiral. On the one hand,

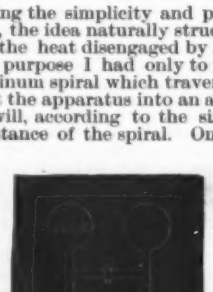


FIG. 4.

the indications of the apparatus are proportional to the quantity of heat furnished it in a given time, and, on the other, the heat engendered in the wire by the current is proportional to RI^2, according to Joule's law. It follows that I can be easily deduced therefrom. On using a fine wire, the instrument becomes a voltameter whose indications are proportional to E^2 on replacing I of Joule's formula by its value, $\frac{E}{R}$, drawn from Ohm's formula. In this particular case the instrument is of the greatest simplicity, It may be reduced to an ordinary Leslie thermometer, one of the bulbs of which is traversed by the platinum wire, as shown in Fig. 4. This instrument is capable of serving for the measurement of alternating currents. Its sensitiveness is very great and its cost is very small. As in electro-dynamometers, the indications are proportional to the square of the intensity.

By preserving the arrangement shown in Fig. 3, the spiral may be easily replaced. It is well to fill the cavity 1 with petroleum or some other non-volatile insulating liquid. One of the calorimeters may serve as a voltameter and the other as an amperemeter, either totalizing or differential, at will.—*A. D'Arsonval, in La Lumiere Electrique.*

A NEW APPARATUS FOR TRANSFUSION, WITH REMARKS ON THE INTRA-VASCULAR INJECTION OF BLOOD AND OTHER FLUIDS.*

By JOSEPH C. HUTCHISON, M.D., LL.D., Brooklyn.

NOTWITHSTANDING the operation of transfusion of blood has been practiced for more than five hundred years, and many brilliant illustrations of its value in saving human life have been noted, it must be reluctantly admitted that it has not fulfilled its early promise, and is now resorted to much less frequently than formerly. Within a few months, however, the prevalence of cholera abroad, and the expectation that it will soon revisit this country, have invested the subject of transfusion of blood and other fluids with new interest, especially since many reports of success have been recently recorded in Europe and America.

The writer has for a long time believed that transfusion would be more frequently practiced, and take a higher rank as a therapeutic expedient, if the means for performing the operation were simplified, its dangers diminished, and a proper and easily obtainable fluid could be found for the purpose.

The object of this paper is to consider these requirements.

Description of the Apparatus.—The apparatus which I now exhibit consists of a cylindrical glass receiver, graduated into inches, with a capacity of twelve ounces. It may be made larger if desirable. A metal cap, containing a perforated female screw, is attached to its lower end, having a perforated nipple-shaped termination, to which a rubber tube four feet long is connected, in order to convey the liquid from the receiver to the cannula which enters the blood-vessel. The mouth of the receiver is closed by a rubber stopper, which prevents the escape of heat, and is perforated in the center to admit a thermometer, which fits the opening tightly. When not in use, the thermometer is pushed well down into the receiver, to prevent it from being broken in handling. The cannula has a nipple-shaped end, which is to be slipped into the distal end of the rubber tube, and is furnished with a stop-cock.

The receiver is surrounded by *a double jacket of India-rubber*, the walls of which are separated by a half-inch space for holding hot water. The water is introduced into the jacket through a tube projecting from the top, fitted with a nipple-end stop-cock. An opening at the top of the jacket admits the receiver, and a smaller one at the bottom allows the metal cap to protrude; it has a narrow opening extending two-thirds of its length, to allow the operator to see the graduated marks on the receiver, and also a loop on the top for suspending the apparatus when in use.

Method of Using the Apparatus.—Drop the end of the rubber tube, to which the male screw belonging to the lower end of the receiver has been attached, into a vessel of hot water (150° to 200° F.) placed three or four feet above the patient, and attach the other end of the tube to the stop-cock at the top of the jacket, the receiver having been previously put inside the jacket, because it cannot be introduced after the jacket has been filled. Now compress the jacket with the hands to expel the air, which will be seen to rise in bubbles through the water; then remove the compression, and, placing the jacket lower than the surface of the water, a siphon is established, which fills it almost immediately. The jacket, when distended, holds ten ounces, and hugs the receiver closely, so that no air can get between them, which would prevent the heat

* Read before the New York State Medical Association, November 12 1884.

from being imparted to the receiver. This method of filling the jacket is most convenient and rapid, and a larger amount of water can in this way be introduced than by pouring it into the opening at the top. In the box with the apparatus are three or four bottles containing the salts which are to be injected, mixed in due proportion, ready for solution, with the formula on the labels.

The rubber tube is now detached from the stop-cock at the top of the jacket, and is attached to the cannula; and the other end of the tube is connected with the lower end of the receiver. The apparatus is warmed by filling it with hot water, which is allowed to run off before it is filled with the fluid which is to be injected. The receiver is then closed with the rubber stopper carrying the thermometer, and the apparatus is suspended or held, by an assistant, three or four feet above the vein which is to be opened.

The vein is exposed by lifting a fold of skin transversely across it and dividing it with scissors or a bistoury, making the incision about three-fourths of an inch long. A probe is carried behind the vein, which is then picked up with forceps and opened, by a V-incision, with a delicate pair of scissors. Before doing this the stop-cock of the cannula should be opened and a small quantity of fluid allowed to escape, for the purpose of carrying off the bubbles of air which may have adhered to the walls of the tube. The rapidity with which the fluid is introduced can be regulated by the stop-cock in the cannula. After the cannula is introduced, it is fixed in position by the finger laid over the opening in the vein; no ligature is necessary to retain it in position.

A vein at the bend of the arm is usually selected for the operation, a bandage having been previously applied above the elbow, as in phlebotomy, to distend the veins; but, when there is difficulty in finding a vein in this locality, a saphena near the outer ankle may be selected, or the fluid may be introduced into the radial artery, as recommended by Hunter, and recently practiced by Halsted. The central end of the artery should be selected.*

A number of appliances have been devised for the purpose of simplifying the operation of transfusion, and for preventing the entrance of air into the blood-vessels; these results can be best obtained by a simple apparatus, constructed on the principle of the one I have exhibited. If the operation is managed with ordinary care, it is impossible for air to enter the vein. The special advantage which this apparatus has is the hot-water jacket. It is a convenient expedient for preventing the fluid to be transfused from becoming cooled below the temperature of the blood during the operation. It is important that the injection should not enter the blood below 98·5° F., and there is no objection to a temperature of 105° F. The temperature can be accurately regulated by the thermometer. —*N. Y. Med. Jour.*

MENTAL CONTAGION IN INEBRIETY: A PSYCHOLOGICAL STUDY.†

By T. D. CROTHERS, M.D., Hartford, Conn.; Superintendent Walnut Lodge.

THE psychological student of to-day finds no support of the theory that many cases of inebriety begin from a so-called stage of vice. This term gives no information of the obscure beginnings of this disorder. The reign of law and the established order of events in the world are found to exist in all the phenomena of the brain and nervous system, and the highest province of science is to search out the facts, no matter what the explanations or conclusions may be.

The progress of psychological study demands the putting aside many theories and ideas of inebriety, because they are contradicted by the facts, as noticed by all observers.

It is impossible to form any accurate conception of the nature and character of inebriety, except from a full knowledge of the history of the case, stretching back to infancy and beyond; including heredity and all the complex conditions of growth and surroundings.

No passing view of any single section of the long procession of life will reveal anything of the origin or history of the march. Every inebriate comes out of the past the result of forces and conditions which have made him what he is, and goes down into the future giving out and taking on impressions that both fashion and change himself, and influence the surroundings. He is a more positive factor in the world than the insane, the epileptic, or the paralytic.

As in physical contagion, which depends on favoring conditions of surrounding for its receptivity and growth, so inebriety often depends on the mental contagion which not only produces the disease, but the condition most favorable for its development,

The neurotic condition from which inebriety most commonly springs is more susceptible to these subtle forces, and in many cases they are as clearly factors in the causation as traumatism and disease.

By mental contagion I wish to describe a certain influence (largely unknown) of mind over mind, resulting in pathological changes of the nerve centers, followed by inebriety. As this is the first study in this direction, nothing more than some outlines can be given.

The object will be to show that many of these obscure cases of inebriety are from the direct operation of psychical forces, cases that are so readily explained by the moralist from a theoretical standpoint, but to the general physician are mysteries.

Like the astronomer who turns his glass for the first time into a hazy fogbank of the skies, and finds it a vast ocean of worlds and suns that move on with majestic order and regularity, so this large army of apparent reckless, wicked inebriates, who are supposed to represent the vice and moral lapses of the human heart, when seen by the eye of science all dissolve into separate atoms, controlled by heredity and environment, and each one follows a definite line of march in obedience to physical laws and forces. From a grouping of a number of these obscure cases of inebriety, some very interesting facts appear. First, the presence of mental contagion as a direct causation in which a previously temperate man becomes an inebriate through the influence and contagion of another.

This contagion which infects a certain number of cases will be found to come from different classes. In describing these classes, the mental and physical condition of persons who are made inebriates by them will be apparent.

It may be stated that the inebriates who come from mental contagion have a peculiar, susceptible nerve organization, either inherited or acquired, and in many cases are lacking in vigor and health. Hence these forces of mind over mind are more potent, and find a ready soil for their growth and development.

The first class of inebriates who are positive sources of contagion to others may be termed the impulsive, irregular inebriates.

Persons whose drinking varies from great extremes at times to a regular moderate use daily, who may abstain for a time and seem to have more or less control over themselves, and are noted for their positive emotional nature, and large, domineering egotism with emphatic manners. These men are found in politics and centers of power, and are frequently wealthy, and often occupy important positions as professional men and leaders.

Often they are full of delusions and on the borders of mania when using alcohol, showing great brain and muscular activity. They are the heroes of apparent power, who compel adoration and admiration in the bar-room, at the club and dinner party.

Such men always gather around them a class of less positive minds, who are attracted at first from curiosity or for some selfish interest, and sooner or later become copies and reflexes. These contagious inebriates are frequently apparent types of health, and ambitious, active men of the world, but when closely studied exhibit manias of expansive, extravagant nature, that are repressed by a very slight current of events. As brokers or merchants they are centers of every new movement, with boundless confidence and hope. As professional men they are agitators and innovators. As politicians they are working on new lines and by new methods. Such men have a short career, and disappear either in hospitals, as chronic cases, or from death by intercurrent disease.

The class of persons who are made inebriates by the contagion from this form of inebriety are equally distinct.

They represent the ambitious poor and the wealthy idler of society; often men of some genius and character, but always of weak, emotional natures. As poor ambitious boys and men, their ideals of wealth and power are changeable, and guided by no fixed conceptions of the means of maintaining these ends. Hence they are attracted by every current of influence which seems to promise this object. If it was stated that some end was accomplished by the excessive use of alcohol, under certain circumstances, they would be the crowd of imitators and experimenters who would attempt it at once.

Possessing unstable nerve organizations, they become followers and imitators of every human embodiment of power and energy, driven by circumstances to apparently better their condition or enjoy more of life,

As wealthy idlers they are attracted by the dash and stir of the surroundings of these contagious inebriates, and, like others, are soon imitators and followers. Imbibing all their delusions with the vague notions of increased pleasure and happiness, they are devotees of the most abject character.

All these cases become inebriates from the mental contagion of a positive, emphatic brain force which forcibly projects itself upon their unstable brain organism, and retains itself through a vague delusion that is steadily increasing. The victim drinks to intoxication, and from this point pathological changes begin, and grow rapidly from the mental as well as physical influences about him.

This may be called the contagion of the nervous and emotional nature, where the motives and conduct of one are imbibed and incorporated by the other, simply taking on diseased impulses and foreign lines of conduct by a sensitive organization susceptible to these influences.

The second class of inebriates who are sources of contagion, and infect a certain number of persons about them with a similar disease, are the regular and so-called moderate drinkers.

Persons who, from some peculiar constitutional resisting power are able, for a long time, to use alcohol regularly, producing in themselves a mild exhilarating effect without going further, and generally able to conceal all excessive use and continue about the same apparently for years. They are the ideal drinkers, who are held up as examples in many ways in every community.

Often they occupy places of influence and power, with wealth, and are emphatic in denouncing inebriety in others, and generally condemn temperance effort.

They are the champions of the moderate use of spirits, and appear at club houses, dinners, and on all social occasions, drinking moderately, and often exhibiting intellectual brilliancy and power supposed to come from alcohol. Studied closely, they are seen to be as clearly inebriates as any other class, only the delusions of the brain and organic degenerations are masked and concealed.

The delusion of health and strength is held tenaciously and urged with emphatic earnestness, forcing conviction in less observant minds, that it is a reality.

As leaders of society they are noted as using wine and spirits freely and yet never to be intoxicated. These men scatter a positive contagion by their examples and arguments. They seem unmistakable examples of the value of alcohol in moderate doses, and the possibility of attaining this end in all cases. They infect the previously temperate, overworked business or professional men, who adopt their ways of living and at once become inebriates.

The contagion of their inebriety makes inebriates of the physically weak and those who are living irregular lives and suffering from neurotic troubles of various kinds, those who are ambitious to be thought strong and to win the favor of these men, and drink as they do by the contagion of example. They infect a class of men who possess weak, unstable judgments, but are able to follow any line of action which breaks in and changes their everyday life. Such men cannot be temperate in the company of moderate drinkers, and they cannot drink moderately, hence are inebriates very soon.

The mental contagion appeals to the reason, and is enforced by the power of example, and the more prominent the man the more positive his contagious influence.

These two classes occupy a very prominent position in all large business centers, and their influence in actually building up and producing inebriates is a positive demonstrable factor that can be seen and understood.

A third class, from mental contagion, less prominent and more obscure, are noted in many cases.

They are the inebriates who grow out of personal intimacies of like characters and organizations. Persons who form attachments, adopt the views and motives of others, imbibing all their delusions, theories, and notions of conduct in life. They are the conscious and unconscious imitators of each other, and are controlled by the thoughts and events which enter into each other's lives. Such intimacies are seen among students, clerks, business and professional men, and grow out of numerous complex unknown conditions. These men frequently possess a clinging emotional disposition, which is governed by the tides and events of each other's lives. They seem bound up in this way, and rise and fall with the person whom they are attached to.

Some illustrative cases will make this class better understood. Two temperate business men who had been intimately associated for twenty years both became inebriates in this way:

One had an attack of pleurisy, with a long, tedious convalescence, for which alcohol was given freely. The other, who was a constant attendant at the bedside, soon began to use spirits for some supposed debility, and both of them drank to great excess, generally together.

Two farmers had been very intimate for years and perfectly temperate. One went to the far West, and was away for over a year, and returned a drinking man. The other, who was a pronounced temperance man, soon became an inebriate in the company of his friend. After drinking for two years with more or less severity, he moved away and reformed, and was temperate for a long time, until his inebriate friend came in his company again; then he relapsed. They both separated, and became temperate; then they came together, and relapsed. Finally, one died, and the other is a temperance man to-day.

The third case was a more striking illustration:

Two railroad officials who had been brought up together, and were temperate, healthy men, and very intimate in all their associations. Both became inebriates. One became an inebriate from the loss of a trusted fund in a mining venture, which produced the most intense sorrow and depression of spirits. This was shared in by his friend, and they both became intoxicated. For the next two years, whenever they came together at intervals for a few weeks, both became intoxicated, and both were perfectly temperate when separate. The moment they came together old mental and physical depressions seemed to start up with great intensity, and the craving for spirits could not be resisted. One of the men traveled in Europe with a drinking party for several months, a total abstainer, and was separated from his friend over a year, and never drank. On one occasion they were separated for two years, and never used spirits, but both were intoxicated within two hours after meeting.

This form of mental contagion is seen in many lesser grades and conditions of life. An illustration of the first and second forms of mental contagion which I have mentioned may be stated as follows:

A noted business man became an inebriate dating from a railroad accident, with concussion of the brain. He became an impulsive, irregular drinker, entered into politics, was very energetic and prominent in the primaries. He gathered about him a large number of persons who had been previously temperate, but who drank with him, and all became chronic incurables. For many years he was the ruling spirit of a club, and a large circle of inebriates, attached to him by his personal magnetism and supposed power, all became imitators and inebriates.

This was an example of the first class of mental contagions from the egotistical, emphatic, impulsive inebriate. The following illustrates the second class:

A manufacturer of large influence, after some severe illness, became a regular and moderate drinker. He defended his position with skill and earnestness, drinking at his own table and in public, and never seeming worse for it. His example and specious reasoning drew into his circle a large number of persons who eventually became inebriates. Nearly all his clerks and workmen followed his teachings, and all efforts to secure sober men in his employ, and keep the inebriates out, failed. Men who came into his intimate circle of acquaintance as assistants in business nearly all suffered from inebriety, and were turned out after a time.

Here another form of mental contagion prevailed, which appealed to the reason and ignored all experience. Illustrations are very numerous of both these classes. They are simply diseased men propagating their diseased impulses on others who are enfeebled by various causes, and peculiarly susceptible to these states of degeneration.

The neurotic enfeebled man, the strained, overworked, aspiring clerk or workman, are as readily infected by these contagions as if they were the poisonous germs of typhoid or small-pox.

Favoring conditions of soil for the nurture and growth of these diseased states are springing up in every community, and all that is needed is the exciting cause to explode into full inebriety.

As long as inebriety is considered a moral disorder, and punished as such, these forces will exist, and infect every community.

The rush of civilization prepares the ground by throwing up vast numbers of neurotic worn-out men and women, and superstitious ignorance permits these infectious inebriates to go up and down the community, irrespective of all consequences or results. The following may represent some of the facts which come out prominently from any general study of inebriety:

1. The term vice, to explain obscure cases of inebriety in the early stages, is without support from any clinical study and history of cases.

2. Inebriety is often propagated from one to another by mental contagion; given the enfeebled, unstable nerve force, in contact with the contagious inebriate, and the result, inebriety, is a certainty.

* *Med. Record*, January 5, 1884.

† Read before the American Association for the Care of Inebriates, at the fifteenth annual meeting, in Brooklyn, N. Y., May 21 and 22, 1884. —*Alienist and Neurologist.*

3. The groupings of these different contagious inebriates are the work of the future. The laws and forces which govern their origin and growth await discovery.

4. This paper, in a mere outline, points out the fact that inebriety is communicated by contagion, and that here, as elsewhere (no matter what the obscurity may be), the same eternal order of events and reign of law exists. The inebriate is no accident or chance result, but follows a line of causes as fixed as the planets.

THE PROPERTY OF ALCOHOL WHICH ALLURES THE NEUROTIC TO DRINK.

By T. L. WRIGHT, M.D., Bellefontaine, O.

IT has been the opinion of men for decades and centuries, and for aught I know, "from the beginning," that the primary and most obtrusive exhibition of the alcoholic influence affords an adequate solution of the motive which actuates the inebriate when he invokes intoxication. It has been supposed that the stimulation of the passions, the exaggeration of the ideas, the domination and enthronement of sensuality, represent the incitements which provoke to drunkenness. It has been the conspicuous sentiment of mankind, with but few exceptions, that these incentives to inebriation were the outcome of depravity of mind and lust of flesh, which were wholly within the dominion of the will and the capacity for restraint. The conclusion, thence, has been almost universal that the practice of alcoholic inebriety, in view of even its more manifest and superficial and circumscribed evils, is an audacious and detestable display of the most revolting characteristics with which the mind, and body, and soul of any human being can be imbued.

Against such sentiments, Dr. Rush, and perhaps a few others, have in the past made some protest. Yet the general opinion as to the moral nature of the drunkard has remained up to a very recent period unchanged.

Latterly—within perhaps half a dozen years—there has been a questioning of the truth of the previous doctrines of mankind upon this subject. Depravity may be punished and restrained through fear; and sensuality may be rebuked, and its exhibition deterred in various ways. But it is found that punishment is of no practical avail in abolishing intemperance; and rebukes and shame are ineffectual in diminishing drunkenness.

It is a curious and an instructive sight which greets the eye as recent changes in the world's opinion of inebriety come under review. At first, protests from careful minds were offered. The old notions as to the culpability of inebriety were cautiously examined. Several inquirers began to hint that alcohol was sought after and demanded, not for stimulation, not for exaggeration, not for ravening lust, *but for repose, for quiet, for rest.*

Here was a revolution indeed; a complete upsetting of all the antiquated ideas on the subject, and a substitution of new and rational principles. And this revolution, too, was fundamental, not superficial. It permeated all the questions and responsibilities allied to intemperance; and it placed the inebriate and his surroundings—the drunkard and the general public—in new relationships altogether. The writer of this, adopting the hints and teachings of such men as Drs. Parrish, Crothers, and Hughes, has for several years advocated the doctrine that the inebriate is, as a rule, a constitutional neurotic; and that his inebriety, when turned toward alcohol, was so directed in search of an escape from a morbid excitement, not an entrance into one.

Under such views, the whole subject becomes clothed with new thoughts and new principles. The primal cause of intemperance is no longer sought exclusively within the organization of the drunkard himself. The unavoidable impressions resulting in a neurotic constitution and in inebriety pertain, very often, to the great and controlling agencies which pervade the universe. Sometimes, it is true, a neurotic predisposition is founded originally by wounds and physical accidents. But anything which has power to strongly impress and warp the constitution may produce a parallel result. Thus heat and cold and the electrical conditions may superinduce inebriety. The occult powers operating in the development of the various morbid states which affect the organization of mankind may work in a similar manner. Disturbances in the equilibrium of the magnetic medium, such as are not uncommon from agitations in the sun, may unquestionably prove profoundly effective in impressing the nervous constitution of man. In short, the primary causes of inebriety may quite frequently be referred to the operation of those great forces of nature which, while they preside over the growth and health of the body, do at the same time, determine its decay and modification.

From these general observations many conclusions are legitimately derived. The originating forces resulting in the neurotic temperament, being oftentimes situated exterior to the human body, the responsibility for drunkenness, as well as the point of reformation, must also, not infrequently, be placed exterior to the human organization and beyond the operation of the human will. It is, therefore, an error held by many that a few years of enforced abstinence from alcoholic indulgence will eradicate intemperance from the earth. For wounds, accidents, diseases, and the innumerable sources of the inebriate predisposition would remain in active force; and were it possible to remove every drunkard out of existence, they would soon fill the world again with countless inebriates.

To refrain from alcoholic indulgence is obviously not always within the voluntary power of the neurotic inebriate. One or two illustrations of this fact, however, may not be out of place. Every man of mature years has seen instances similar to those following:

Major W——, forty years old, a printer, had passed through the civil war with credit as a soldier. He was a man of more than average intelligence. Periodically he was a hard drinker, furious with drunkenness for days, and then sober and remorseful for weeks. He made every promise and every effort to abstain permanently from liquor. He was engaged to be married, under the condition that he would control his besetting propensity for a given time. Still he would drink and spree—always remorseful thereafter, and pledging himself anew. At last realizing the futility of his endeavors, despairing and ashamed—when sober and sorrowful—he walked out to a lonely spot in the darkness of night, and casting himself before an advancing train of freight cars, he met his fate.

Another instance:

W. L—— was also a soldier during the late war. These poor inebriates are often soldiers who have borne the shocks and hardships and diseases and wounds of war. Their nervous powers have been unsettled and thrown permanently out of equipoise. This man was a spasmodic drunkard. Becoming a government clerk in Washington, he was peculiarly subjected to temptation. He repeatedly tried to reform. He would sign the pledge, and solemnly promise himself and friends to quit drinking. At length, after an unavailing warfare against a constitutional predisposition, extending over a period of more than twenty years, at the end of a debauch, when all about him thought he would soon return to duty, he drew his razor across his throat, and so died.

In such cases as these, when the supreme moment comes wherein self-respect and the opinion of the world demand decisive action, we see, not reformation, but suicide.

The discussion of the anæsthetic powers of alcohol has opened to view an entirely new field for inquiry. Indeed, in relation, to the principles which are associated with the alcoholic temperament, the consideration of anæsthesia is like entering upon a new world. Eminent men are daily assuming the study and discussion of the anæthesia of alcohol, as it presents itself in its manifold modifications. The recent paper by Prof. Palmer, in the *Journal of Inebriety*, upon alcohol as a *paralyzing** agent, is a good disquisition upon one of the many phases of the subject.

The relentless unrest of the constitutional neurotic; the ever-acting erethism of the weakened and poorly nourished nervous system; the agonizing appeal for repose which goes forth from the neurasthenic—ever thinking, and with no power to rest or change—these are some of the conditions hurrying the mind to insanity, which turn to anæsthesia and to alcohol for help. They seize upon strong drink as their best and only friend.

It is a great step toward unveiling the truth to recognize the fact that anæthesia is indeed that property of alcohol which is paramount in importance. And it is a substantial advancement to discover that the soothing and lethal property of alcohol is that which so imperiously demands the homage worship of the helpless neurotic. This vindicates to some extent the manliness even of disease, for it shows that it is not always the riot of lust or the satisfaction of inordinate and maniacal stimulation which incites the inebriate when he seeks intoxication.

PASTEUR'S WORK.

IN the recent address of Mr. Ernest Hart before the Society of Arts, London, on the result of the Health Exhibition, he said: I shall ask leave now to refer you to an exhibit which was made in the French Court, illustrating the work done by M. Pasteur in a similar laboratory to that of which I am now advocating the permanent establishment, as the best possible sequel of this great exhibition.

M. Pasteur is the scientific director of the Ecole Normale Supérieure in Paris, a school especially designed to supply professors in literature and science to the *lycées* or higher schools of France. He is not, however, called upon to undertake teaching, but is expected to devote all his time to his researches. In a word, in consideration of the considerable national services which he has rendered, an exceptional position has been accorded to him. He receives a professorial salary of 400*l.* a year. M. Pasteur is also the head of l'Ecole des Hautes Etudes, of which Mr. Chamberlain is the sub-director. In this laboratory he receives some pupils. He possesses further a laboratory at the Ecole Normale, where M. Roux is his coadjutor, and where are admitted some students who are generally persons already known for their studies. He has entire freedom of the choice of students of the laboratory of l'Ecole des Hautes Etudes, as well as those of persons who work in his private laboratory at the Ecole Normale. About 800*l.* a year are allowed for his laboratory by the Minister of Public Instruction, and for the last few years, 30,000 francs from the Minister of Commerce and Agriculture. These grants are renewed yearly.

The principal researches of M. Pasteur have related to—

(1) *Wine*, in which he demonstrated that, in order to avoid the transformation of alcohol into acid, it is necessary to destroy the germs remaining in wines which are poor in alcohol, by heating them up to 55°–60° Centigrade. He has also studied the action of oxygen and light on wine, and has demonstrated that it is to this action, *i. e.*, to the oxidation of the materials of wine, that we are to attribute the development of the bouquet of wine, *i. e.*, the flavor which it acquires with age. In order that this may yield a product appreciated by amateurs, it is necessary that it should proceed slowly. He has further demonstrated that the ferment of wine exists on the surface of the grape when it has ripened. He has demonstrated the useful and precise indications which the areometer furnishes, in order to appreciate during fermentation the state of the *mout* of the grape.

(2) *Beer.*—After having demonstrated that brewers employ, generally, a ferment containing, among others, injurious germs, M. Pasteur indicates the following means for obtaining a pure ferment. A small quantity of pure yeast is prepared according to the exact rules of the laboratory. This is introduced into a large copper pan, three-quarters filled with the wort of beer which has been first carried to the boiling-point and then cooled before the introduction of the yeast. The vessel only communicates with the external air by a long tube of copper, many times bent, in such a way as to permit the gases to escape without external germs being able to enter. When the wort has been developed, it is drawn off by a tap placed in the lower part of the apparatus, and which is previously purified with the flame of a spirit lamp. The wort of the beer is put to ferment in a large white metal vat, resting on a plank, and closed by a movable cover, this movable lid dropping into a groove which is kept full of water. As the wort arrives in a boiling state in this vessel, it destroys any germs which may exist there. When it is cooled—and the cooling may be rapidly aided by the use of external cooling water—the yeast is introduced through an opening in the lid. The aeration of the fluid is obtained by two tubes curved downward, by one of which carbonic acid escapes, and by the other the air enters after being previously filtered through a layer of cotton wool rolled round a cylindrical cage on metal wires which cap the extremity by which the air enters. This apparatus, like the foregoing one, reproduces exactly the conditions which are found to be necessary in the laboratory to prevent the introduction of external germs. The aeration by these two tubes is sufficient, for the carbonic oxide being heavier than air, they are placed in such a way as to form a siphon; moreover, during the fermentation the wort is certainly kept in movement by the ebullition of the gas which escapes, so that the aeration, although less active than in some of the technical apparatus previously in use by brewers, is more than sufficient. By employing this procedure, secondary fermentations are no longer to be feared, and the spoiling of beer by secondary fermentation is almost entirely put an end to.

(3) A third and profoundly interesting series of researches, which have had a great influence on agriculture, carried on by M. Pasteur, are those relating to *charbon*—the malignant pustule or black quarter of cattle and sheep. M. Pasteur has demonstrated that animals of the ovine and bovine species may be prevented from contracting the disease of *charbon* by inoculating them with attenuated germs, obtained by artificial cultivation of the specific minute organism which is ascertained to exist in the case of *charbon*, and to be the efficient cause of the disease. This attenuated preventive material for inoculation is obtained by the aid of what are known as cultivations of the germs made in special liquids. After the first inoculation with the highly attenuated virus, Pasteur has shown that the second inoculation may be made with a product of medium virulence, and that the animals thus twice vaccinated were unsusceptible of contracting the disease. Pasteur has further demonstrated that the bacterium of *charbon* is capable of retaining its vitality for several years in the earth, and that, when brought to the surface by earthworms, it is capable of infecting the animals which eat the grass polluted by its contact, especially if the grasses or plants so eaten be hard, and such as to cause abrasions in the mouth and digestive tube.

(4) *Silkworm Disease.*—M. Pasteur, after having assured himself that normally, and in good health, silkworms never contain, at any moment of their life, the bacteria or corpuscles seen for the first time by Guérin Menneville, demonstrated that the eggs of the worms, even when only slightly attacked, contained a great number of these corpuscles or bacteria, which developed in considerable quantities when the animal underwent its metamorphoses, and finally destroyed it. Since its droppings polluted the leaves of the mulberry on which the silkworm feeds, and as healthy animals thus devoured them, and contracted the same disease, a single infected silkworm was capable of destroying a whole school of worms, and preventing the subsequent cultures from being developed.

M. Pasteur then laid down the rule that, in order to avoid the silkworm disease, it was necessary to choose with extreme care the animals which were to be employed for breeding. With this view he devised the following procedure: When the female has laid its eggs, it is at once destroyed. If a single corpuscle is found in its tissues, when crushed in water, the eggs are immediately burned. In the same way the several eggs of each hatching are carefully examined. If no corpuscles are discovered, the whole brood is preserved for culture; if any are found, the whole are immediately destroyed. Since that time the silkworm breeders have followed the rules of M. Pasteur. The implements for the purpose of recognizing the diseased worms consist of a microscope, two objectives, one with low power, and one with high power, magnifying about 400 times, and a porcelain mortar for crushing the tissues of the worm or its eggs, some glass slides, and a flask of distilled water. By this application of scientific research to the silkworm industry, the silkworm disease has been almost wholly put an end to. Nearly all the silkworm growers, whether masters or servants, have learnt by the aid of a very cheap little handbook, prepared by M. Pasteur, to recognize diseased worms or eggs from healthy eggs or worms, and thus a great industry, which was threatened with extinction, has been saved from the fate which threatened it.

(5) *Fowl Cholera.*—After having demonstrated that this affection is caused by a micrococcus, M. Pasteur showed that if this micrococcus is cultivated in the manner which he indicates, and the micro-organism thus obtained inoculated in a fowl, the fowl so vaccinated become proof against fowl cholera, even when they are placed in the midst of other infected fowls. These researches have a special and suggestive scientific interest, for he has shown that if you filter through plaster the liquid taken from the external foci of the disease in a fowl affected with fowl cholera, the filtered liquid thus inoculated will not give a healthy fowl the specific disease, but render it somnolent and inert for some hours, so that it may be concluded that the micro-organism secretes a material to which must be attributed the lesions which are observed in fowls suffering from fowl cholera.

Some idea may be obtained of the commercial value of the work done by M. Pasteur in his laboratories from the following facts and figures, which I have on very good authority: In three departments of the center of France, after the silkworm disease had attacked the factories, the product yielded a value of less than 1,500,000 francs. Since the regulations laid down by Pasteur have been applied, the average value per annum, calculated on five years, in those departments has risen to more than 22,000,000 francs.

As to wine, there was a known loss of wine to the extent of 1,700,000 francs in four departments. Since heating on Pasteur's method has been applied, there has been saved of this loss at least 1,500,000 francs; the difference of 200,000 francs being alleged to be due to the carelessness or ignorance of small proprietors, who are unwilling to heat their wine. As there are in France about forty-five departments that make wine, the saving may thus approximately be estimated. I should add that there are twelve departments that make silk.

In respect to anthrax, the following was the official statement indicating the ravages made by this disease

* To be strictly accurate, the property of alcohol as a *paralyzant* was at first pointed out by Dr. T. W. Poole, of Ontario, in a book published by him in 1879. Dr. C. H. Hughes has also several times called attention to the same point.

in France and foreign countries, and the reduction of mortality effected by these inoculations:

1881.	Sheep.	Oxen.	Horses.
France	62,050	5,977	142
Foreign countries	12,500	1,254	100
Total	74,550	7,231	242
1882.			
France	270,040	35,654	1,825
Foreign countries	36,830	6,169	200
Total	306,870	41,823	2,025
1883.			
France	268,205	26,453	371
Other countries	84,825	5,777	975
Total	353,330	32,230	1,346

The average mortality reduced by these inoculations in the proportion of 10 to 1 for sheep, and 15 to 1 for oxen, cows, and horses.*

[N. Y. SUN.]

THE PRISON OF LOUVAIN.

IN the whole of Europe there is but one prison in which the *systeme cellulaire* of absolute isolation by day and by night is still enforced, and it has, on that ground, a strange and sad celebrity. That one prison is the Maison Centrale of Louvain.

In England and in France prisoners are submitted to less severe penalties, for although they are condemned to silence, they at least work in common, walk in common, pray in common, and confinement to their cells is only a temporary measure recurred to in case of insubordination or misbehavior. The question now pendent in France of replacing the actual penitentiary system by the solitary system adopted in Belgium gives interest to the details of a visit paid to the prison of Louvain.

The buildings are situated on the anterior boulevards, nearly outside the town. They date from twenty years back, but their tall reddish walls have retained the freshness of newness. Admission to the interior can only be given by the Minister of Justice, who grants the permission with so much difficulty that the rare visitors are always treated with the utmost courtesy and consideration, and enabled to see as much of the interior administration as is consistent with the rules and discipline.

The buildings all converge to a central apsis, whence a warder can easily survey the six immense avenues or wings, consisting of two stories of cells. While some slight repairs were being done to one of these cells, a figure suddenly appeared standing motionless at the door—a mysterious and ghastly apparition, clad entirely in white linen, head and face closely masked by a hood of the same material. Air was admitted to eyes, nose, and mouth by four round holes. Obeying a rapid sign from the warder, the figure turned to the wall, and crossed its hands behind its back. It was a convict.

Even through the apertures of his concealing headgear, the prisoner of Louvain must never catch a passing glimpse of any human face beyond his keepers, and no breath of the outer world must ever pass upon his shrouded cheek. He wears his linen hood summer and winter, but during the cold he is provided with warm brown woolen clothes. Labor is compulsory, and the days are spent in one unvarying monotonous round of self-same duties.

At 6 o'clock the peals of an organ wake the convicts. They come from the chapel, all the doors of which are thrown open, and the prisoner who can play the organ strikes the first chords. This is the signal for all the others to rise, dress, and make up their beds and bedding. The music lasts for fifteen minutes, and may, at the will of the player, consist of religious anthems, operatic airs, waltzes, or polkas—notes that must strike with dreary significance on the ears of some of the wretched beings cloistered there. They do not all belong to the dregs of society. Leon and Armand Pettyer are there expiating the murder of the lawyer Bernays, whose trial two years ago startled the world by its cynical revelations.

At the last sound of the organ the warders must find each man at his work. Breakfast consists of half a pint of coffee and bread, and the two other meals of the day of soup and vegetables. Three times a week the convicts have fresh meat, but never wine. The convict who has earned a certificate of good conduct, however, can procure some at the prison canteen, as well as beer and tobacco in stated quantities. Each day the prisoners are taken out of their cells in rotation for solitary exercise in separate yards. The rest of the time is entirely given up to the accomplishment of their allotted portion of work, except on Sunday, which is a day of absolute rest. Between the religious services the convicts are at liberty to employ their leisure in their cells as they think proper. The prison library contains a considerable collection of books of travel, and such publications of the "Magasin Pittoresque," from which each man can make a selection. Only those who can neither read nor write are compelled to attend school for instruction between mass and vespers. This takes place in the chapel itself.

Nothing can be more striking than the construction and internal arrangements of this chapel. It is a large cycle, or wheel, consisting entirely of superposed flights of steps, like a circular and reversed amphitheater, the center of which forms a raised stage, on which stands the altar, towering far above the heads of the phantom-like congregation. Each row of steps is divided into compartments or pigeon holes, just large enough for a man to sit and kneel. When the hour for divine service has come, the first cell is opened by a warder, and convict No. 1 is led out, conducted to the chapel, and, entering the row to which he belongs, walks to the furthest compartment, which at once closes upon him. Then only No. 2 leaves his cell, and goes through the same performances. And so on till all are settled—no man being permitted to move till the one immediately preceding him has entered his allotted pen. After mass they are all taken back into their cells in the same order and with the same precautions.

There are about twelve flights of steps, containing sixty seats each, but as the circle of the chapel is divided by five or six immense partitions, into each of which the prisoners are carried simultaneously, the operation takes comparatively only a short time.

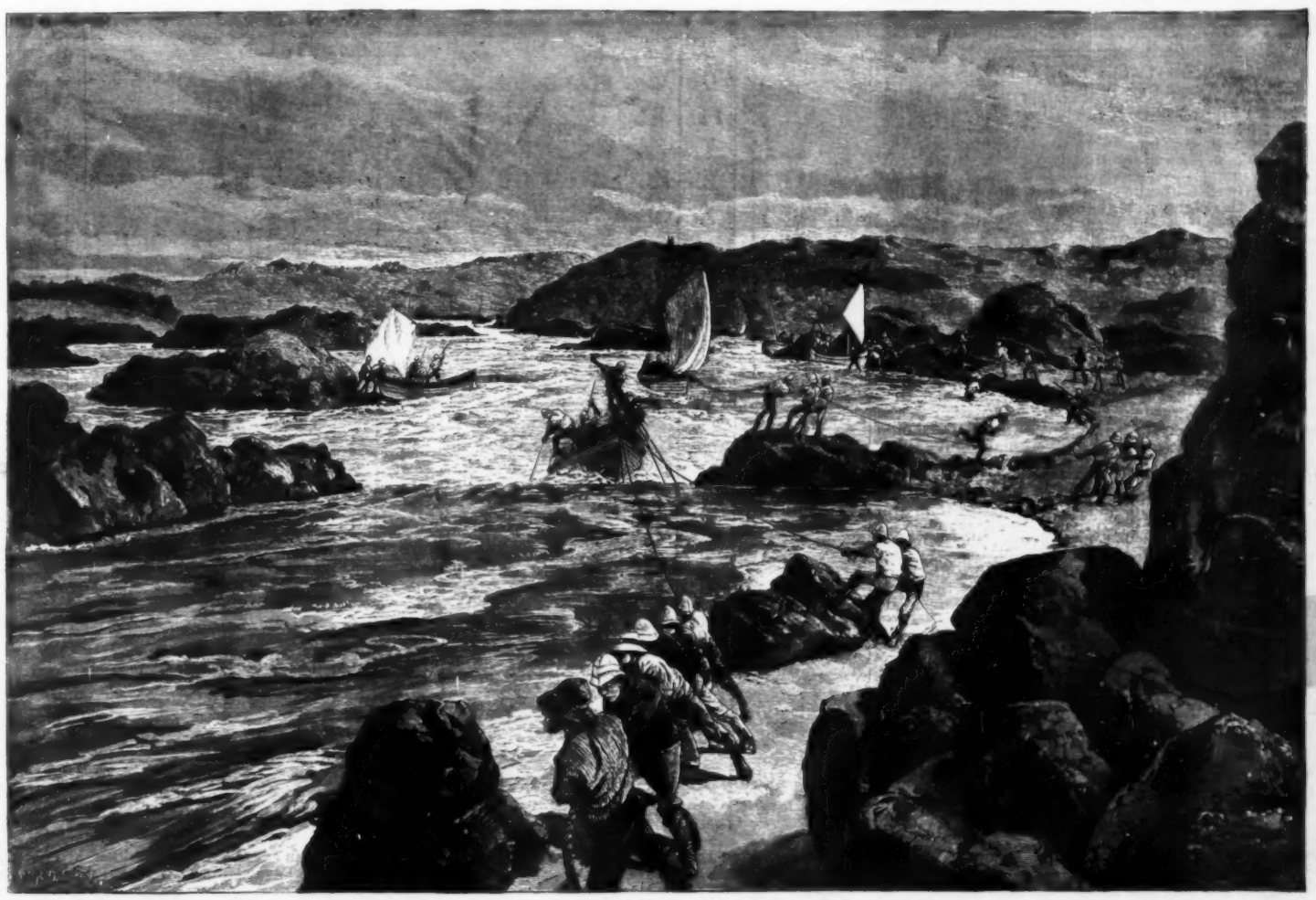
From his stall each convict is able to see and follow every movement of the priest who officiates at the altar on the central platform, while he cannot catch even a glimpse of his right and left hand neighbor, owing to to the height of the dividing doors, nor can he look over at the opposite row, which is hidden by a boarding higher than himself, and which as effectually shuts out from his view those above or below, before and behind him.

The cells are clean and well arranged. Daylight is admitted by a small window beyond the prisoner's reach. The ventilation is perfect. In winter the mouth of a hot air pipe gives sufficient heat, and in the evening the necessary light is procured by a gas jet, to which there is no access from the interior of the cell. The furniture consists of a washstand, a commode on the best sanitary principle, a shelf supporting some pewter utensils, and an iron bed. The bedding is a foundation of sacking, a mattress, two sheets, one blanket in summer and two in winter, and a bolster. The convict has to fold and put these things away. The bed itself is taken to pieces and placed against the wall, forming a table in front of which is a stool. The remainder of the space is taken up by the implements necessary to the convict's obligatory daily task.

Some of the convicts are shoemakers; others bookbinders, tailors, carpenters, even smiths. The new comer who knows no trade is taught one. Those who have had a superior education are employed in copying students' essays. The produce of each man's labor is divided equally between the state and himself. This latter portion is again subdivided, one-half being put aside for the day of his liberation, if not incarcerated for life, and the other deposited at the canteen for his private use. His earnings never exceed two or three cents a day. In the evening, labor ended, he dines and goes to bed. To the dreary silence of the day succeeds the dreary silence of darkness.

The rules of the prison are such that the convicts must replace their hooded masks as soon as the doors of their cells open. They cannot expose their faces even to their warders. If perchance a face is seen by a doctor, it is paled by the long sunless shadow in which it lives and the want of bracing, blowing air, for even the daily walk of an hour in the prison yards is at best only exercise in cramped passages between two high walls, partly roofed, shut in by iron gates, stretching out like the sticks of a gigantic fan, and where a few stunted plants soon wither and die. The prisoners have that flaccid fleshiness which comes from absence of movement and stimulating activity; yet in contradiction to the opinion prevailing in France that no man could stand solitary confinement for ten years without succumbing or getting insane, it has been found not to be the case at Louvain. Two of the inmates have dwelt there since 1864, the date of its foundation, being transferred to the Central house after a ten years' imprisonment at Ghent. They had been condemned to death, but, owing to the virtual abolition of the penalty of death in Belgium, the King had commuted their sentence to the perpetual entombment of their present abode. When prisoners have deserved an alleviation of their penalty by ten years of interrupted good conduct, they are sent to Ghent, where the rules of the prison allow of their working in common.

The secondary buildings contain the infirmary, laundry, linen rooms, bath rooms, bakeries, and kitchens all kept with a scrupulous cleanliness, remarkable even



THE BRITISH NILE EXPEDITION.—TOWING THE WHALE BOATS WITH TROOPS THROUGH THE FIRST GATE OF THE SECOND CATARACT.

* In the last thirty years there has been an increase of life duration of from 39·9 to 41·9 years, an increase of 5 per cent. human duration of life. The annual economy of life, on the least favorable calculation, during the last five years, has been equal to a saving of 36,000 lives per annum. The money saving on the last five years has been calculated, on good basis, by Capt. Galton, to be in London alone nearly half a million of money per annum.

in that land of unrivaled cleanliness. Huge iron pots contained an abundance of excellent potatoes boiling for the evening meal, and the bread, although brown, was sweet, crisp, and of better quality than that rationed out to the army.

None but isolated cases of revolt have ever taken place at Louvain. These are punishable by incarceration in a subterranean dungeon containing nothing but a single wooden bench, where nearly total darkness prevails. The time of retention within its walls cannot exceed eight days, during which the prisoner is kept on bread and water. This mode of punishment is rarely resorted to, as there is another which is viewed with far greater dread—the privation of work! For those silent recluses, this labor is the only link which connects them ever so remotely with the living world. It is more than an occupation—it is a favor, a recreation, almost a pleasure; and the threat of taking his tools from him rarely fails to insure the submission of the rebel.

Whether or not the system of solitary confinement has greater advantages for the repression of crime and the security of the community than the system of labor in common now generally adopted in penitentiaries, and which only half sequestrates the offender from his fellow creatures, is a question not easily or lightly solved; but it is impossible to leave the Maison Centrale of Louvin, admirable as its administration is in the minutest details, without a feeling of almost superstitious horror at the vision of those miserable beings cloistered in eternal isolation, doomed to unbroken silence, buried in their livery of infamy as in a shroud, the face of each remaining as sealed to his six hundred companions of crime and shame dropped in to the same tomb with himself, as if the lid of a coffin had closed upon it and the hand of death forever obliterated its features.

M. DE S.

ASSYRIAN SCIENCE.

MR. W. ST. CHAD BOSCAWEN lately delivered a series of weekly lectures at the British Museum on "Assyria;" the attendance was large. In the course of his address the speaker drew attention to the amount of scientific knowledge possessed by the dwellers in the city of Nimrod, mentioned in the opening chapters of the Book of Genesis, and he stated that the present knowledge of the manners and customs of the people who dwelt in those cities during a period ranging from 2000 to 4000 years B.C. is considerable, even to the details of the lives of certain private persons down to their very family squabbles. As to their scientific knowledge, they had made some progress in mensuration, and they laid down plans of building "to scale;" their standard of measurement was the Babylonian cubit, which they subdivided into a number of equal sections. They had a table of square and cube roots, they calculated by the scale of 60, and they divided the circle into 360 parts.

In the earlier periods, their sculpture, in which they were advanced, was more true to nature than in the later periods, when it became conventional. He should like to know what the British workman would think of the material they carved, for it was porphyry, so hard that it would turn the edges of the best chisels; in all probability they used the diamond drill, as the Egyptians certainly did, and spent unlimited time over their work out of fealty to their king or reverence for their God. They worked bronze with the hammer, and they cast statues with the same alloy; one of their earliest hymns speaks of a good man shining like brass cast out of a crucible. In music, they had the harp, pipes, and cymbal. They knew the colors assumed by light; Mars was described to them as a red orb, and Mercury as a blue one; in one of their hymns a scribe speaks of the sky being as blue as the sea.

They had words for the compound as well as the primary colors, including names for reddish-brown, purple, and gray. Blue and purple were connected in their minds with the idea of darkness, and the same appears to have been the case with the ancient Greeks; he was not quite sure that such was the case with the latter people. The Euphrates Valley, in fact, was the cradle of civilization; upon its banks were city kingdoms, each city having its own king, one of whose duties it was to sit at the gate of the city to give judgment. Old commentators had found various sites for the four cities of Nimrod, varying in position from Ireland to the banks of the Ganges; but modern explorations had solved the mystery. The true site of Babylon was the only one which had been preserved by tradition; the literal interpretation of the word "Babylon" was "The Gate of God."

The subject of the second lecture was

"THE LAND OF NIMROD."

Mr. Boscawen said that as, in the former lecture, he had shown that the cuneiform mode of writing was the vehicle of expression employed by many varied languages, so the researches of Assyriologists revealed the fact that these inscriptions contained the memorials of several distinct races of men. Berosus, the Chaldean historian, in writing of the early inhabitants of his native land, calls them a mixed multitude of all nations; and the opening phrase of the royal proclamations in the Book of Daniel—"Be it known unto all people, nations, and languages"—would be just as applicable to the subjects of the great king 25 centuries before the Christian era as it was in the third or fourth. The reason for this mixture of races was to be found in the extremely attractive nature of the Tigris-Euphrates Valley and its suitability to form the cradle of a great civilization.

We could readily imagine, the lecturer said, how attractive this fertile region, called in its own records the "garden of the gods," "the land whose streams flow with milk and honey," must have seemed to the Akkadian highlander as he descended from his rugged, forest-clad, and snow-crowned mountain home in Kurdistan, or to the parched and panic-stricken Bedouin from the Syro-Arabian desert. Mr. Boscawen then proceeded to show how the explorations of Mr. Loftus, Sir Henry Layard, Mr. Rassam, and recently Mr. De Sarzac had brought to light from beneath the dust of the mounds scattered over the Chaldean plains the records over the four cities of Nimrod. He described the sites of the various cities. Of the position of Babylon there had never been much doubt, as tradition had always lingered round the mounds to the north of Hillah, one of which bore the name of Babel.

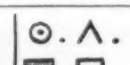
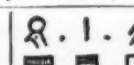
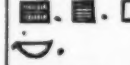
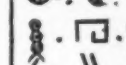
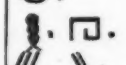
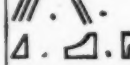
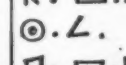
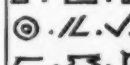
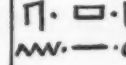
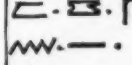
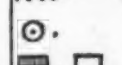
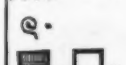
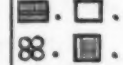
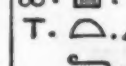
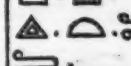
North of Babylon about 30 miles was the city of Akkad, called Agadhe by its early founders, the ruins of which were found by Mr. Rassam buried beneath the mounds of Aboo Hubba. To the south of Babylon was Erech, the ancient Uruki, the royal city of Gisdhubar, the hero of the Chaldean epic, whose exploits in war and the chase identify him with Nimrod, and its ruins were now called Warka. The explorations carried out by M. De Sarzac had enabled us to identify the last of the four cities of Nimrod—namely, Calneh—with the Kulunu, or "city of the people," the ruins of which were marked by the mounds of Tel-Lo, on the Shat-el-Hie, about 15 miles southeast of Warka. The lecturer proceeded to show how vast was the information afforded by the monuments and inscriptions obtained from these cities as to the life, manners, and customs of the subjects of the hunter king.

The early civic life in its patriarchal simplicity resembled to a remarkable degree the early Hellenic polity, as revealed to us in Homer. The temple was the center of religious and, to a great extent, of secular life. It was the school of the young, the court of justice, and the revenue office, or treasury, of the community. Describing the social life of the people, he said magic, demonology, and astrology seemed to rule every event in their lives, and he quoted examples from the tablets to show how superstitious the people were. The tablets containing square and cube roots, the neatly drawn plan of a temple discovered by M. De Sarzac, indicated that the Chaldeans had at least as early as the 26th century B.C. mastered the theory of numbers and the elements of mensuration. Evidence of their skill in the arts of sculpture and drawing was amply afforded by the monuments in the British Museum and the Louvre, and even the arts of pleasure, such as music and dancing, were known, as shown by sculptured representations of the harp, reed-pipe, and cymbals, with groups of dancers.

Mr. Boscawen concluded his lecture by drawing a comparison between Egyptian and Chaldean primitive culture, remarking that while in the former the conservative and exclusive character of the priest class had exercised a fettering influence, stereotyping the literature and conventionalizing the art of the nation at an early period, in the latter the analytical mind and progressive nature of the Semitic element had caused the learning and wisdom of Chaldea to grow and develop until it spread its influence far and wide over surrounding lands, and, indeed, kindled the first flames of Western learning.

THE MAYA ALPHABET.

IN continuation of the interesting contributions of Dr. Le Plongeon, concerning the Maya remains in Yucatan, and his remarkable discoveries thereto relating, we now give the Maya alphabet, which Dr. Le Plongeon, after many years of research, has finally succeeded in deciphering. Dr. Le Plongeon is satisfied that the ancient Egyptian civilization orginated on the American continent, and he is in possession of a vast number of evidences which, he believes, fully establish this extraordinary theory. One of these is the resemblance between the Egyptian and Maya alphabets as derived from the monumental remains of the two systems. For the sake of comparison, Dr. Le Plongeon has placed both alphabets side by side, and we herewith present them for the consideration of our readers:

	ANCIENT MAYA HIERATIC ALPHABET, ACCORDING TO MURAL INSCRIPTIONS. BY DR. A. LE PLONGEON.	EGYPTIAN HIERATIC ALPHABET ACCORDING TO M. CHAMPOLLION, LE JEUNE.
A		
B		
C		
H		
I		
K		
L		
M		
N		
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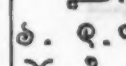
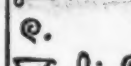
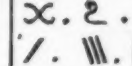
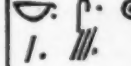
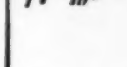
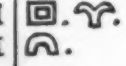
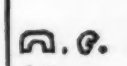
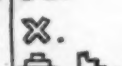
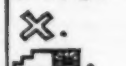
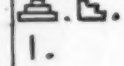
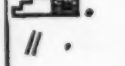
P		
PP		
T		
TH		
U		
X		
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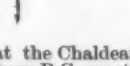
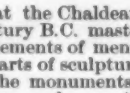
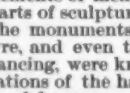
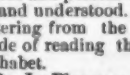
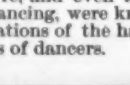
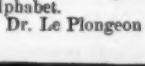
Z		
CH		
CH		
TZ		
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The Egyptian example is that written by Champollion the celebrated Egyptologist. By the aid of Le Plongeon's alphabet many of the wonderful carved inscriptions on the tombs and palaces of Yucatan may now be readily translated and understood. We give herewith examples of carved lettering from the ancient buildings of Uxmal, and the mode of reading the same in connection with the Maya alphabet.

Dr. Le Plongeon writes as follows:

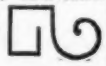
FIG. 1.—MAYA INSCRIPTIONS, UXMAL.

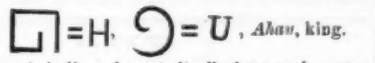
MAYA INSCRIPTIONS, UXMAL.

In the city of Uxmal there is a high pyramidal mound adjoining the palace called the "Governor's House." This mound, described by John L. Stephens, who visited it in 1842, seems to have been the site of terrific struggles. It is to-day in a state of utter destruction. All the facing stones have been removed, or are buried under the debris. Its north angular edge abuts the southwest corner of the second of the three platforms serving as base to the palace. The sides of the mound were of yore highly ornamented, when, once upon a time, it served as a bulwark or fortress for the protection of the palace and of the other edifices that lay at its base. A large frieze adorned with bass-reliefs, among which were heads surrounded by legends reciting that the building had been dedicated to the seven members of the family of King CAN, encircled the summit. To day a small portion of it only remains, nearly entire, on the west side. This fragment may serve as a specimen, and help us to imagine how beautifully grand and majestic must have been the appearance of the structure when entire and in good repair.

I offer here (Fig. 1) a photograph of that fragment—a most interesting witness of the past, whose testimony throws a brilliant light on the history of the founders of the ancient cities of Mayax, and on their attainments in the art of writing; as may be collected from the translation of the legend surrounding the head that forms the center of the tableau; and was intended to recall the memory of CAY, the king of the priests.

The crown that encircles the head, forming the central part of the tableau, indicates that the individual represented was a chieftain, while the legend placed each side of the face, tells him to have been a king. Effectively, said legend reads:

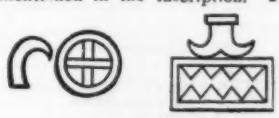




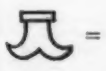
= H, = U, *Ahau*, king.

His family name is indicated symbolically by a snake entering the mouth at each corner. Snake in Maya is said *can*, and mouth *chi*, therefore the symbol reads CANCHI: a family name still existing among the aborigines. This interpretation is confirmed by the symbol short uplifted trunk placed over the eyes of the mastodon's head. It contains his full name, being composed of two letters, = *i*, that is, 2 = *ca* and *i*—*cai* or *cay*, and the framework made of sticks is called in Maya *canchi*. So we learn that the chief whose memory was thus recalled was named CAY CANCHI.

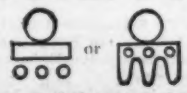
Following the interpretation, we find that the names of the city, and that of the country, are likewise mentioned in the inscription. The sentence,



reads: = *u*; = *luumil*; = 2 *n* = *can*,



= *chi*. As to the word placed over the possessive pronoun = *u*, it is the name of the city. numerical character *ox* = 3, and the letters = *m* and = *a*, *l*, *ormal*, which we have found also written on the facade of the sanctuary—



or

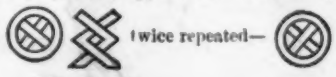
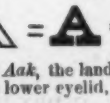
In this building, we find that the sculptures over the doorway of the sanctuary have been altered, at the time of the fall of the CAN dynasty.

There is an ancient MS. said to have been found at Mani. It is called the Pio Perez MS., after the name of the gentleman who obtained possession of it, and translated it from Maya into Spanish. It was published for the first time with an English translation by John L. Stephens in 1841, in the appendix of his second volume of "Travels in Yucatan," and republished in the Proceedings of the Worcester American Antiquarian Society, October 21, 1879. It is written in the Maya language, but with Latin letters; proving that the author belongs to a period posterior to the Spanish conquest. It purports to be a history of the invasion of Yucatan by the Nahuatl tribes, that, in or about the fourth century of the Christian era, overran the peninsula, destroying many of the principal cities, and dealing the deathblow to the ancient Maya civilization. Having become masters of the country, they established themselves at Uxmal, on account of its strategic position, in a fertile plain, at the foot of a low range of hills easily defended. Uxmal was then a flourishing metropolis; contained splendid public edifices, the ruins of which are to-day much admired. They defaced the facades of these buildings; and among the devices of the family of King *Can*, that formed their principal ornaments, inserted the symbols of their religious worship—that of the reciprocal forces of nature. That they destroyed the ancient dynasty of the CANS, who had governed the country from times immemorial, there cannot be the slightest doubt, since they have taken care to perpetuate the memory of the fact by a commemorative inscription, which they placed in the monument held most sacred, that which was also, and is still, the first to attract the attention of the stranger by its loftiness and the beauty of its architectural proportions—the Sanctuary, commonly called the "House of the Dwarf." The family of the *Can* worshiped the unseen god, the vivifying Spirit of the Universe, and called it KŬ; but represented it under the figure of the mastodon, the largest, strongest, and most intelligent of the denizens of their forests. This is why its head and trunk form so conspicuous an ornament in all the most ancient monuments of the Mayas. It is seen of gigantic size over the doorway of the sanctuary. The invaders defaced that venerated symbol: and, in lieu of the trunk, infixed the naked figures of two men crouching on their hands and knees, on all fours, as dogs. The trunks of the mastodon, turned downward, serving instead of ears, depend slackly as those dogs (see Fig. 2). These figures are an emblem of the condition to which had been reduced the ancient worshipers of the mastodon, rulers of the country; and in order that all should understand the meaning of said emblem, care had been taken to place over it the following motto: which means, *The Cans are now without strength, without vigor, like the ears of dogs.*

The mode of reading it is as follows: the four dots, • • • •, represent the numerical 4, in Maya *can*, which is also the name of the founder of the city, King Can, and of his dynasty; as is *khan* that of the kings of Tartary, and the title of the governor of a province in Persia even to-day. The character is equivalent to our P P, and is our letter A, twice repeated.

The inscription would therefore be: *canob ppaapp*. This last word is said to-day *papach*, and it signifies, according to the Pio Perez Maya dictionary, *fallen, without strength, as the ears of a dog.*

Round the eyes of the mastodon's head (see Fig. 3), also described by the character , *a*, equivalent to *ah* or *ich* = *ich*, the eye.

Over the eyes, on the upper lid, as it were, we see the inscription  twice repeated— *luumil*, land, country; , *Aak*. This character is a monogram of the name of Aak, brother to *Cay* and *Coh*, sons of King Can. The monogram is composed of two intertwisted =  so as to form the letter K, thus reading *luumil Aak*, the land, the country, of Aak. Under the eye, on the lower eyelid, we find sculptured these characters:

A most significant inscription. The character corresponds to the double letter TZ; and is the syllable *an*; the dot • part of stands for the whole A, and is our letter N. We have, therefore, the word *Tzantzanta* spelt with all its letters as we spell it with our Latin. But owing to the inevitable changes that languages more or less suffer in the course of ages, this word is written to-day *Tzantzantal*, its meaning being, *very strongly tied up, securely fettered.*

Then the commemorative inscription recording the downfall of the *Can's* dynasty, and the conquest of the country by the Nahuatls, reads: "THE CANS NOW FALLEN ARE CROUCHING LIKE DOGS, WITHOUT STRENGTH; THE LAND OF AAK, OXMAL, IS SECURELY FETTERED."

AUGUSTUS LE PLONGEON.

January, 1885.

FIG. 2.

FIG. 3.

THE CULTIVATION OF THE RAMIE PLANT IN THE UNITED STATES.

By MAX JAGERHUBER.

THE ramie, like the great majority of cultivated plants, has its home in the Orient, and which appears destined to make a similar conquering march around the world as its predecessors flax, hemp, and cotton made in their time. The name of this plant, which belongs to the stingless *Urtica*, or nettle, is now well known to every intelligent person. It is indigenous to the far East Indies, China, Japan, Bengal, Java, Sumatra, Borneo, Celebes, the Molucca Islands, and all other islands in the Indian Archipelago, and has gradually found its way to all parts of Europe and now to America too.

The Asiatic peoples have known from the earliest times how to produce a number of valuable articles from the fine, silky, pliant, and uncommonly strong fibers of this precious plant, from the finest and most elegant dress-goods, called *seersucker*, and also known under the name of Canton silk, to sail-cloth, ship-rope, and fishing-nets. The fiber was loosened from the bark and the very tough, resinous gum that binds the woody part of the stalks together, by means of a dull knife. In 1810, an Englishman, John Marshall, of Leeds, succeeded, if not wholly, at least partially, in overcoming the difficulties of treating the gum by adopting a chemical process. It took him and his sons forty years of incessant experiments before succeeding in placing the plant in the service of industry. He first showed this at the London Industrial Exhibition of 1851, where his ramie products excited the admiration of the learned world and the textile industry, who were unanimously of the opinion that a great future awaited the plant.

And really the most daring expectations have been since surpassed. Owing to the great progress made in chemistry and in valuable mechanical inventions, it is now possible to lay the glossy fine fibers completely bare, and to prepare them for dyeing in the most brilliant shades as for bleaching. There are at present German, English, and French ramie manufacturers, such as sliver and noils, natural bleached and dyed yarns, cambrics, diapers, velvet, chenille, cords, curtains, single or double, with half silk or wool stuffs, fringes, etc., that are not only striking evidence of the qualities of this fiber of the future, but also of the eternally new creative genius of man, for which no problem seems too hard to solve.

Hundreds of acres are now devoted in France, Spain, and Portugal to the cultivation of the ramie plant, and serve as so many nursery gardens. A number of plantations have also been made within the last five or ten years in Egypt, Algiers, Spain, France, Mexico, and Ceylon, which cover some half million acres in all probability, and of which every acre, according to received accounts, gives an average clear profit of $100.

Among the large number of *savants*, manufacturers, and investigators that have made a special study of the cultivation of the ramie plant, and that have been prominently connected with the final solution of this important question, we must mention a German gentleman who has been domiciled in America during the last two years, viz., Mr. Felix Fremerey, formerly publisher of the *Rhenish Jacquard*, Aix-la-Chapelle, but now living in Newark, N. J. Mr. Fremerey's scientific treatises on the nettle family in general, and the ramie in particular, had made him generally known in European industrial circles; and, when these were reproduced in American journals, textile manufacturers and agriculturists had their attention likewise drawn to him, and perceived that he was just the man to introduce this useful article in this country. After a great many attempts, the services of this energetic apostle of

the ramie were acquired for America, and at present he is hard at work by word, pen, and, what is more, by active action, to gain America for the ramie fiber, and had made a beginning to that effect in the swamps of New Jersey, which are peculiarly adapted for this plant. This transformation of the Jersey swamps, which no one had previously considered as good for anything, into blooming fields of ramie, was made a somewhat lighter task when Mr. Fremerey found the most suitable material, the *Urtica postulata*, growing wild in the neighboring Pennsylvania mountains. This *Urtica postulata* is an extremely valuable plant, with numerous strong and glossy fibers that are far superior to those of the European nettle, *Urtica dioica*. The same may be said of the abundant and wild-growing plant, the Syrian silk plant, or swallowwort, *Asclepias cornuti*, that also produces a great number of fine, strong, and glossy fibers.

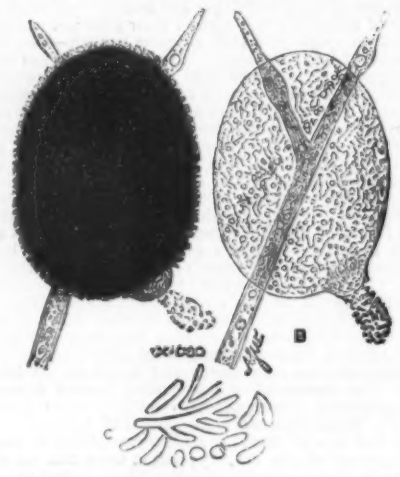
All the *Urticeæ*, as well as these *Asclepias*, are perennial, and can be planted either by seeds or sprouts. Both of them require only a little care during the first year to keep them free from weeds. In the second year they throw out a number of strong stalks, with numerous leaves, that choke off any weeds about them. With regard to the soil, it should be loose, and retentive of humidity. The plant requires a like watering during dry weather if they are to give two crops in the year in temperate climates, and four or five in the southern latitudes. The forest nettle as well as the *Asclepias* flourishes sufficiently in a poor soil, and whether it be dry or wet, to give an annual crop and a clear profit of from $40 to $50 per acre. The life of the plant is unlimited, as the dying plants are replaced continually by fresh growths.

It is not surprising that such a hardy and profitable plant should excite some enthusiasts so far as to cause them to recommend its cultivation in regions farther north than New Jersey, while science and experience alike show that it cannot be grown profitably higher than the 41° of latitude. Still it may be possible in time to acclimate it in more northern latitudes, but for the present the practical agriculturist is recommended to abstain from any such attempt on an extensive scale. In the suitable latitudes and soil the *Urtica* and *Asclepias*, with their $40 to $50 profit per acre, can be all the more warmly recommended that the flax grown in the east of the States does not return more than from $20 to $35 per acre.—*Dry Goods Bulletin.*

THE POTATO DISEASE.

I took little bits of potato leaves (Ashleaf, Pink-eyes, and Magnums), some in which disease had not begun, and some in which the watery green extensions of black spots indicated the currant inroads of mycelic lines, and put them in cold water for maceration four or five or more days. A bit was then put under a low power to find if a fair number of well-defined bodies were present. A smaller bit of such a leaf was then teased out with needles upon a slide in plenty of water, in order, if possible, to isolate some of the bodies from the leaf tissue altogether. A thin cover was then placed over the broken-up materials, and a low power was run over the field to hunt up detached sclerotia. The first was sighted just touching a palisade cell at one point. The keener scrutiny of a tenth was placed over it. And now with fear and trembling the drops of nitric acid begin to enter from the upper edge of the cover. A hair pencil removes the water ejected at the lower edge. In less than a half a minute the lime crystals grow transparent at the optical edges of the ball, the solution becomes more rapid, and in another half minute (for the acid is labeled poison) not a particle of lime remains. But there where the opaque sphere had disappeared stands convicted a pellucid ball of granular plasm. Perhaps it will disappear too. Let us look at it before it goes. The mass is highly translucent. A conidiophore looms through it. It is everywhere pervaded by sporidic granules, some of a round form, others of an oblong form, like short pieces of excessively delicate mycelium. The whole has a soft hue, like like fine pencilling, and the outline is in most places perfectly definite, with here and there a break as if part of the material had flowed out at the side. It is not disappearing; more acid is applied, but what had so rapidly discharged the crust of lime has no effect on the wall of fungal plasm which supported it. There it stands very visible for hours in the strong acid, not obscured by leaf-cells, not at all capable of having its burglarious existence denied, but a thing of some kind or other asserting itself for a fact.

This experiment, with the body in most cases completely isolated from all tissue taken from various leaves, and performed at various dates, I repeated four-and-twenty times, with the same results. Sometimes the little clean ball stood in the acid over night below the microscope, and presented the same appearance in the morning as it did fifteen hours before.* In some cases there were little streams



SCLEROTIUM OF PHYTOPHTHORA INFESTANS, FROM POTATO LEAF.

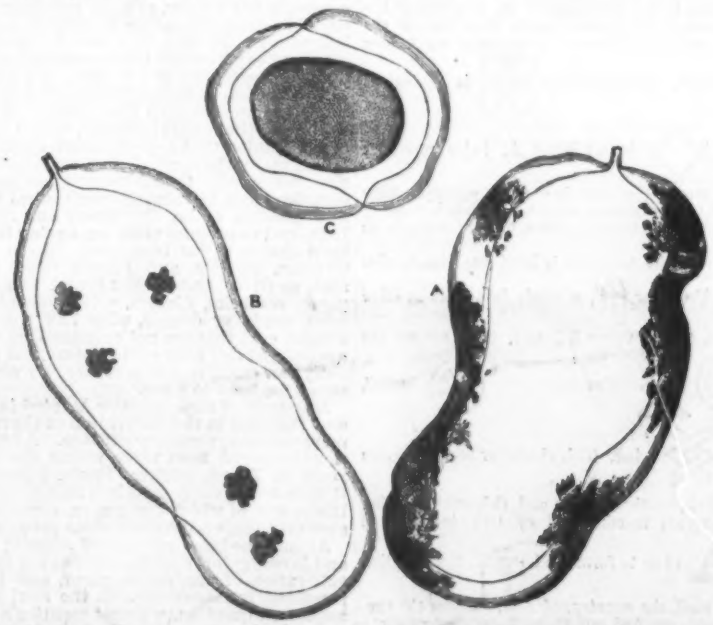
A, As seen by transmitted light before treatment with nitric acid; B, After treatment with nitric acid; C, Myceliating granules seen in B.

of granules flowing out from the body before treatment; these were not affected by the acid, and presented the same optical reactions as the granules of the body itself and the granules in the surrounding lines of mycelium. A conidium of Phytophthora infestans is about half the size of one of these bodies within the leaf, and the contents of the conidium are optically very singular to those of the sclerotium as seen after being divested of its calcareous coating, and both equally give rise to mycelium. A thin slice of a very young and still white sclerotium of Typhula incarnata also presents nearly

Changes seen in the bodies from potatoes when treated with nitric acid, as sketched by Mr. W. G. Smith. Enlarged 400 diam.

the same resemblance, only myceliation is more pronounced.

In a few cases measurements were made before and after the lime was removed. In one case the diameter was reduced from 0·050 mm. to 0·047. In another case the dimensions were reduced from 0·059×0·045 mm. to 0·048×0·036; in another case no sensible reduction was observed.



DISEASED POTATOES: A, FROM PHYTOPHTHORA; B, INTERNAL SPOTTING; C, DRY ROT.

That some of the minute plasmodiating fungi are normally coated with lime is well known, indeed a covering of lime is characteristic of certain genera of the Myxomycetes, as the reader may fully see in Dr. Cooke's *Myxomycetes of Great Britain*. The Chondrioderma, for example, have the sporangium well "incrusted with granules of lime, sometimes quite shell-like." And in the *Gardeners' Chronicle* of July 15, 1882, Mr. W. G. Smith describes and figures a Myxomycete covered with crystals of oxalate of lime.

My previous observations and experiments, which seemed to me to prove the genetic connection between these lime-covered bodies and the conidiophores of P. infestans, were chiefly directed to the tracing of mycelium lines up to the granular materials of these bodies. I have now to thank the Royal Horticultural Society, and more particularly Mr. George Murray and Dr. Flight, for directing attention to chemical tests. The results of these are most satisfactory and convincing, and leave no doubt that the "seeds" of any outbreak of potato disease are insidiously lodged in the plant while yet in its healthy condition. The theory thus involved, worked out in a short treatise, rather overweighted with illustrations, has been lying beside me for a year or so, and may see the light some time, now that a formidable-looking objection has been cleared away. The suggestions which it will offer toward the elucidation of parasitic life, both animal and vegetable, may possibly have some value in showing why it is necessary for one organism to become parasitic in another, and in showing that the destruction or damage of one vital form is an incident in the perpetuation of another. The Peronospora infestans can be matured and perpetuated only by the potato disease.—*A. Stephen Wilson, The Gardeners' Chronicle.*

* One was fifty hours in acid, and remained perfectly unchanged.' I have had young sclerotia of Typhula incarnata for weeks in strong nitric acid undergoing no change.

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